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VIBRATIONS.

The rapid advances made by the Hertzian theories, or rather, through the German savant's experimental demonstrations, of Faraday's and Maxwell's conceptions, have given an interest to the subject of vibrations in general, and in our present issue Prof. Dolbear discusses the effect on living beings of waves of widely different period. It will be noted that one of the conclusions is that the human body may be affected by waves of which it has no sensation, owing to an absence of a nervous organization capable of detecting their influence.

SENSIBILITY OF GALVANOMETERS.

Prof. Stine elsewhere in this issue calls attention to the uncertainty and confusion existing in the rating of various types of galvanometers, and lays down certain principles which should govern the determination of a rational rating. Those using sensitive galvanometers are as a rule not easily imposed upon by incorrect ratings, and the manufacturers of such instruments could not afford to deliberately deceive the class of customers with whom they deal even if they desired to do so; nevertheless, there should be some convention in order to secure uniformity, and the principles laid down by Prof. Stine would seem to offer the necessary basis.

ELECTRIC POWER FOR WORKSHOPS.

The data contained in the abstract of Prof. Crocker's Institute paper, printed elsewhere in this issue, on the amount of power required to drive various kinds of machine tools, form an important contribution to the subject. The difficulty of obtaining these data by former methods was very great and therefore affected their reliability, but with electrically driven tools it is merely a matter of reading an ammeter and voltmeter. As a consequence, the data given in the paper are probably the most exact yet determined, and are besides sufficiently comprehensive to make it now possible to rapidly and certainly estimate the power required for a given shop. With a prospect of the speedy general adoption of electric power for driving tools, the paper referred to is therefore a most timely one.

EFFECTS OF DISTRIBUTED CAPACITY.

In another column we print an interesting article by Prof. A. S. Kimball on some experimental investigations to determine the effect of distributed capacity with respect to closely wound coils. The method employed is a very neat one and the results obtained showed that the effect of capacity may be sufficient in the case of a transformer to justify the application of means to overcome it, and that it should be taken into account in even some of the ordinary electrotechnical measurements. In the neutralization of a distributed capacity, theoretically a distributed inductance is necessary, and it would be interesting to determine experimentally if the divergence has any importance in practical cases if non-distributed inductance is used. It may be added, though somewhat foreign to the present subject, that it has been found practically advantageous to distribute the resistance which is thrown into the armature circuit of an induction motor to reduce the reactance when starting.

THE WESTINGHOUSE ANNUAL REPORT.

We print elsewhere the report of the directors of the Westinghouse Electric & Manufacturing Company for the year ending March 31, which shows that the business for the period covered netted a profit of almost three quarters of a million, notwithstanding that the output was decreased about 25 per cent. on account of

the interruption of work and extra expense entailed by the removal to the new East Pittsburg plant. As will be seen, the company during the past year has considerably extended the scope of its operations, having entered into close financial relations with the competitors of Edison Illuminating Companies in New York and Baltimore, and undertaken the direction of the affairs of the English Westinghouse Company. Much confidence is expressed in the new electric railway system operating by means of underground circuits, recently described in our columns, and we learn that the first of the Tesla patent suits will be ready for trial by Oct. 7. The balance sheet makes a good showing, the absence of detailed information in regard to the items restricting comment to this statement. It may be added, however, that the valuation of patents, franchises and charters, $4,404,4 9.45, seems excessive; on the other hand, this unfavorable feature, if such it can be considered, is largely balanced by the presence of a surplus of $3,979,400.21.

THE NIAGARA MEETING OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The general meeting of the American Institute of Electrical Engineers at Niagara added another to an already long list of successes, and still further advanced the standard for the future to maintain. A matter of regret, however, was the small attendance of Western members, which should bring to the fore the question of a more equitable division of meetings between the East and the West. While a preponderating portion of the membership is in the East, such a division would, in these days of long journeys, cause little inconvenience practically, and would secure to the Institute that national character upon which its success depends, and toward which it has taken such great strides during the past two years. We believe, therefore, that both good policy and fairness require that the next general meeting be held in the West, and feel satisfied that any initiative taken by Western members in the matter would be given final effect by the Council. As to the sessions of the meeting, it was again apparent that rules are urgently needed to limit the time of reading papers, and to confine discussion within reasonable limits. With printed papers at the disposal of the members for days sometimes in advance of their reading, it is a sheer waste of valuable time for a paper to be read in full at the sessions; a rule seems, therefore, necessary, providing that a paper shall be read in abstract, or a limited time only allowed the author for its presentation. The matter of limiting discussions is a more difficult one, as there are always several members whose remarks, however frequent, are always to the point and welcome to the audience. By imposing a five-minute limit, with discretion accorded to the presiding officer to extend it, or to recognize a member more than once during the same discussion, the value of the discussions would probably be enhanced, and the audience certainly saved from considerable infliction.

RECONSTRUCTING UNPROFITABLE CENTRAL STATIONS.

The Institute paper of Mr. Franklin L. Pope, reprinted elsewhere, is of timely interest in view of the condition of many hundreds of our present central stations with respect to antiquated machinery. As remarked by Mr. C. E. Emery in the discussion of the paper, it is a model presentation of facts, and there are many stations similar to that of Great Barrington which the management might remodel from its indications without any other information. As a rule, however, each case will present special problems requiring particular solutions, and a competent engineer should therefore be consulted in order to make certain that the best results attainable may be secured. In the present instance, for example, a number of the methods adopted would have been by no means obvious to one who had not a wide knowledge of electrical engineering, or who did not possess the courage to make radical innovations from previous local practice. An uninsulated line, private right-of-way, the substitution of street incandescent for arc lights, utilizing old 1,000-volt high frequency transformers on a low frequency 2,000-volt system and the new system of distribution adopted, as well as the expedients resorted to in order not to interrupt the lighting service for a moment—all of these and other solutions required the judgment of an engineer, and formed integral parts of a well-considered plan based upon all of the conditions of the case. In reconstructing a plant there is a natural tendency not to depart too widely from previous practice, partly through the conservatism due to a lack of a working knowledge with the daily advances of engineering, and partly from a desire to utilize as much of the old plant as possible. While the latter consideration is a proper one, yet it should be subordinated to the engineering conditions rather than that the latter should be considered secondary. A competent engineer undertaking the reconstruction of a plant would give due weight to all of the considerations present, and usually be much more likely than the local management to carry out the work on broad lines. In most cases, also, a radical reconstruction is more desirable than a gradual approach to modern methods, if for no other reason than the favorable influence the more striking results in the former case would have on the community.

MAYOR STRONG AND THE TELEPHONE INTERESTS.

We have repeatedly referred in these columns to the desirability of a reorganization of the New York City Board of Subway Commissioners, which, to speak frankly, has been generally considered nothing else than a mere creature of the telephone interests. Upon the advent of the reform administration we expressed the hope that the Commission would be so reconstituted as to relieve it of this reproach, and at the same time afford an opportunity for an investigation of the charge that "the great City of New York has been delivered over to the Metropolitan Telephone & Telegraph Company to be taxed at its own sweet will." We also commented upon the fact that during the first months of the administration, the Subway Commission, against which the gravest charges had been made, was, very singularly, the only department of the city government to which the reformers did not give their attention. On almost the last day, however, of the period during which Mayor Strong possessed the power of summary removal, a change was made, but one which will serve to strengthen the conviction of those who believe that the power of the telephone interests is indeed an unlimited one. The change to which we refer is the appointment of a Platt man, and a henchman of the notorious "ex-wicked Gibbs," to a place on the Subway Commission, to fill the vacancy created by the removal of ex-Congressman Amos J. Cummings. We know nothing of the new appointee, Mr. T. L. Hamilton, personally, but in view of his backing, it is beyond the bounds of credence that he was appointed with any idea that the public interests would thereby be subserved. Notwithstanding his Tammany affiliations, Mr. Cummings had in his favor a record which showed him to be in sympathy with the interests of the people, and is possessed of an independence of character which at least would have prevented him from becoming a pliant tool. An appointee of Boss Platt, however, is open to the worst of suspicions, particularly in view of the open charges which have been made to the effect that Platt derives his political revenues from assessments paid by corporations to secure immunity from adverse legislative action. The majority of the Board now consists of Platt's man and "Jake" Hess, whose name has been unfavorably connected with every charge made against the Board since its inception—such are the vagaries of "reform!" We are in constant receipt of communications showing a widespread belief throughout the country that the immense power of the telephone monopoly reaches to the highest departments of the government, and has even corrupted the judiciary, and the action of Mayor Strong with respect to the New York Subway Commission will serve to deepen these suspicions, unjust though they may be.

Dimensional Formulæ and the Theory of Units.

BY TOWNSEND WOLCOTT.

Prof. Fessenden's article in the issue of June 29, replying, or intending to reply, to my criticism of his former articles, leaves unanswered the more important points of dispute. I claim that Prof. Fessenden and all of his school of thought constantly commit the error of confounding numerical equality with logical identity.

The ordinary algebraic equation means that there is a numerical equality between the two members, and not that they are physically, logically and every otherwise the same.

Prof. Fessenden says "I regard dimensional formulæ as a legitimate form of mathematical analysis." So does your humble servant, providing the rules of algebra are observed, and this is precisely what my former communication stated, my principal contention being that Prof. Fessenden and other Rückerians use extra algebraic reasoning, if reasoning it be at all.

It will be observed that Prof. Fessenden does not specifically answer the points I raised, but reiterates his statement in another form albeit based on the same logical data, the validity of which I question.

For instance, Prof. Fessenden states that "there is one and only one correct dimensional formula for any given quantity, and that if by any method we arrive at two different formulæ, one of them is incorrect." This is certainly algebra extraordinary. If by any method (even a correct algebraic method) we arrive at two different results, from two different fundamental assumptions, one result is necessarily incorrect. Of course, one assumption may be incorrect, and so also the corresponding result, but that rests on independent evidence, and is, moreover, here excluded by hypothesis: the only thing *proved* by the different results is the *independence* of the original assumptions.

The passage just quoted from Prof. Fessenden is a corollary to the alleged fact, "That the dimensional formula of a quantity is a full and sufficient definition of the nature of that quantity, so far as it is possible for human knowledge to go."

This is the same idea in different language, but does not carry us one whit nearer to a logical foundation for this extraordinary dictum.

As to Prof. Rücker's alleged discovery, I would like to see that logically expounded also. This Prof. Fessenden does not do. Although I attacked the validity of Prof. Rücker's result (or, more strictly, denied that he had produced any result), and although Prof. Fessenden accepts this alleged result as a starting point, he says nothing in his last communication in regard to the subject, unless the statement "That this idea" (Maxwell's) "was erroneous has been perceived, thanks, I believe, to the work of Prof. Rücker," be so regarded.

As Prof. Fessenden admits that he is at variance with Maxwell in the matter, and as Maxwell is commonly accepted as authority therein by all fair rules of argument, the *onus probandi* is upon Prof. Fessenden. Unless he can start from known and acknowledged facts and work up to the proposition quoted, by legitimate mathematical reasoning, no one is called upon to contradict his conclusions in detail, much less to accept them.

Electric Traction in Paris.

Up to the present the only applications of electric traction in Paris have been the accumulator lines to St. Denis from Neuilly, Place de l'Opera and the Madeleine. A number of other projects, will, however, presently be put in execution. In the month of May the municipal council awarded two franchises for underground electric lines, one of which is for a line from Place Cadet to Place Montmartre; the system employed will be that of Holroyd Smith, which has been in use since 1885 at Blackpool, England. M. Claret, the inventor of the electric railway shown at the exposition at Lyons, which is operated on the momentary contacts system of distribution, will establish a line from Place de la Republique to Romainville.

The National Telephone Company.

A Chicago telegram in Saturday evening's newspapers report that the National Telephone Company had made an offer of $15,000,000 for the property of the Postal Telegraph Company, which offer was refused. The telegram states that the offer was made in order to get possession of lines by means of which to compete with the Bell Long Distance Telephone Company.

The American Association of Inventors and Manufacturers.

The American Association of Inventors and Manufacturers, of which Dr. Gatling is president, has issued an address bringing the objects of the association to the attention of inventors and others. The organization has been formed to promote common interests by securing the active co-operation of inventors and manufacturers in the collection and dissemination of the best information and opinion on the development, protection and management of inventions and patent property.

For this purpose the association maintains a central office in Washington, in charge of a permanent secretary, and besides the regular officers, there are standing committees to whom are intrusted the more important subjects within the scope of the association's work.

One of the most important of these committees is the Committee on Legislation, which looks after numerous bills before Congress, appears before the congressional committees whenever required and, through reports and other papers, keeps the members advised of the progress of legislation. The importance of this work will be appreciated when it is remembered that no less than 53 bills relating to patents were before the last Congress, and that many of these bills were inimical to the rights of inventors and owners of patents, while some of them strike at the very root of the patent system itself.

The association publishes, and furnishes free to its members, papers on subjects relating to the nature and protection of property in inventions and patents, and holds annual meetings for the presentation of papers and the consideration of questions relating to these and allied subjects.

A New Electrical Phenomenon.

The study of crystallization has provided its devotees with many beautiful effects, not to say delightful surprises, says the London *Electrical Review*, and although our knowledge in this direction is not very extensive, every year large accumulations are made to it, especially to that branch known as crystallography. Now among those effects which we have referred to as beautiful is the following: At the moment of crystal-forming, some substances emit a flash of light. This can be demonstrated easily. For example, let a glass cylinder be half filled with warm saturated sodium chloride solution, and into it let there be poured an equal quantity of hydrochloride acid (sp. gr. 1.12); then let the solutions be well mixed by stirring with a glass rod, when a bluish-green light will pervade the whole cylinder. Or the two liquids having been carefully poured in so that the one is superimposed upon the other, let the cylinder be suddenly and strongly shaken, when a flash of light will occur. Alcohol may be used in place of the acid, and similar effects may be obtained by the use of potassium chloride or bromide, instead of the sodium salts. So much for the way of producing the phenomenon. Hitherto no one has said much more regarding it than that it is very beautiful and interesting—an obvious sort of conclusion, which has at least the merit of being a safe one. But now we find E. Bandrowski coming forward with a theory which, if unassailable, will place this phenomenon in that ever-increasing category of what we style "new electrical phenomenon." He considers that the light emitted during crystallization is electrical, and is due to the union of electrified ions. If this is true, the light should be more marked in the sudden crystallization of strongly dissociated compounds. And this appears to be the case.

A Unit of Sound.

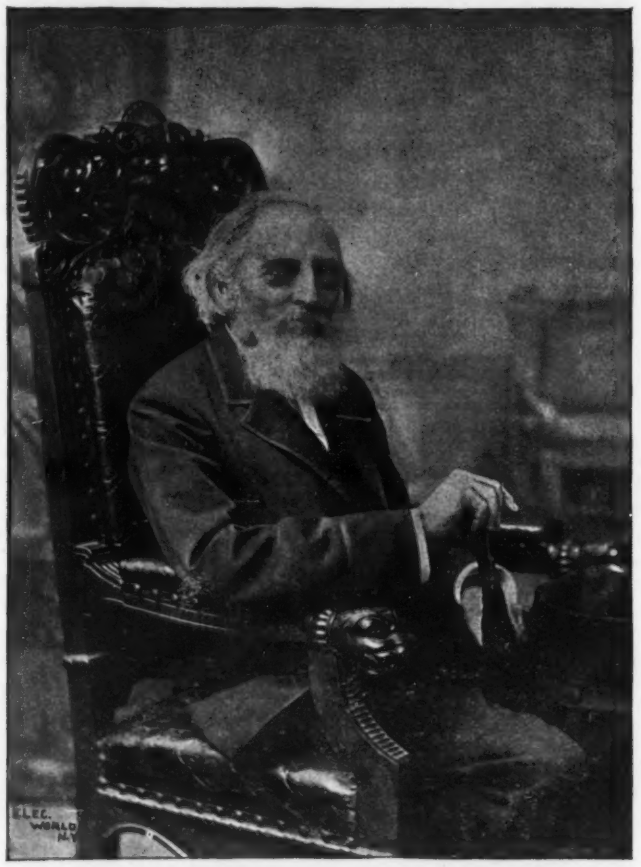
Hiram S. Maxim, in London *Engineering*, suggests the adoption of a standard of sound claiming that it might be a ready means of deciding some complicated questions which are brought before the courts; by this means it might be distinctly decided, for instance, whether noise in houses caused by vibrations of machinery in neighboring central stations is or is not greater than the ordinary noise of street traffic. He believes that the noise produced by a passing cab is much less than that produced by a central station. He suggests, as a starter, that a kind of phonograph be employed making a record on smoked glass which could be enlarged in a lantern, and by this means a noise made by a factory, for instance, might be compared with that produced by a Salvation Army band, or other disagreeable sounds which are tolerated by law. As a standard of noise, he suggests a shot of a certain size dropped from a certain height on to some standardized diaphragm, the waves being recorded at, say, five metres distance.

P. H. Vander Weyde.

BY N. J. VANDER WEYDE.

The life of the late Dr. Vander Weyde is a fair illustration of the way in which inventors are often robbed of the fruits of their labors. In his chemical and physical researches he would often make discoveries the personal money value of which he would fail to recognize, and valuable ideas he did not appreciate as being patentable were freely given to the public who attended his lectures. *Pro bono publico* seemed to be his motto, but private individuals often appropriated his inventions and robbed the public, if not the inventor, by patenting them as their own, committing both theft and perjury in the act.

While lecturing on the subject of electricity at the Cooper Union in the early sixties, he exhibited to the class an electric rubber syringe constructed by him from an ordinary piston syringe, the piston being replaced by a specially made leather piston covered with



P. H. Vander Weyde, M. D.

amalgam the friction of which on the inside of the hard rubber cylinder produced frictional electricity, a circle of points collecting it as soon as produced, the piston and points being each fastened to brass rods, which were insulated from each other, but formed one continuous piston rod protruding from either end of the rubber cylinder, with a handle at one end and a brass knob on the other; all that was necessary in order to obtain an electric spark from the brass knob was to work the piston rod back and forth once or twice. In showing it to the class he had a gas burner arranged to be lit by a spark of electricity from this syringe, the experiment causing much interest, as electric gas lighting was a novelty at that time.

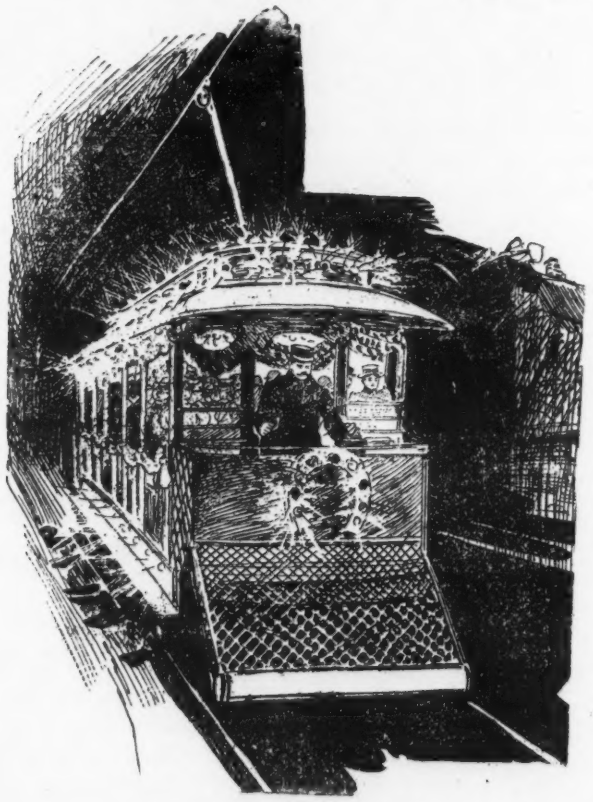
The doctor always took a lively interest in any experiments his students might attempt, and when a young man came to him the following week with an electric syringe of his own make, which would not produce electricity, the doctor was ready to investigate and show him the why and the wherefore. The collecting points, instead of being insulated from, had been placed against the leather piston, so that the electricity was neutralized as soon as collected. His error being pointed out he thanked the doctor, but turned up again in a few days. The syringe was then able to produce a small spark, but nothing like that of the professor's. It was then discovered that he had only separated the circle of points from the piston by a sixteenth of an inch insulation. He was, therefore, advised to put in a half an inch or more. This was, no doubt, successful, as the party did not appear again. Dr. Vander Weyde subsequently discovered while visiting the Patent Office that this young man had obtained a patent for the invention, and had sold it to a manufacturing concern for several thousand dollars.

Trolley Parties in Philadelphia.

The Hestonville, Mantua & Fairmount Passenger Railway Company, of Philadelphia, some time ago inaugurated a novel method of increasing its traffic, which has since been adopted by other electric lines of that city. The New York *Herald* of last Sunday, from which we reproduce the accompanying illustration, says that with the advent of the trolley car feature to which we refer, Quakerdom has been seized with an epidemic which has now reached the violent stage, and the quiet of the night is rudely disturbed by the shrill echoes of tin horns, brass bands and shouts of merriment.

One of the earlier stages of the evolution of the trolley car was the adoption of colored lights around the sides and over the roofs of the cars, and the different street railway companies have rivalled each other in producing the most artistic effects with colored incandescent lamps. The People's Traction Company, the Electric Traction Company and the Hestonville Passenger Railway Company are the three enterprising street car corporations in the city to adopt these fanciful cars for the special delight and edification of the trolley party. Nightly they may be seen in the street, crowded with merrymakers, and not infrequently adorned with flags and fancy-colored drapery, through which the muffled strains of a brass band occasionally mingle with the laughter and merriment.

The colored lights, the flags and bunting, and the bands of music are all progressive stages in the evolution, but the very latest of the stages is the adoption of a trolley car buffet by the Hestonville line. As yet the buffet is only designed for the special comfort and enjoyment of the trolley party, but there is no telling when its peculiar beneficence may be extended to the lot of the ordinary traveler.



Pleasure Car "Mascot."

Recently it built several cars with folding seats and an aisle running up the centre. The cars are known as the aisle palace cars. They are enclosed all around the sides with bronze grill frames, and have cushion rattan seats, with comfortable backs. They are probably the handsomest trolley cars running in the United States, and there has been a pressing demand for them for summernight excursions. The company recently equipped one with 265 colored electric lights, the lamps running all over the roof and even up the trolley pole. There was such a demand for the car that the directors decided to call it the "Mascot," and it carries its name in a blazon of brilliant lights in front.

Vibrations.

BY A. E. DOLBEAR.

The wide range of vibrations between the highest rate to be perceived by the ear and the lowest rate perceived by the eye has led many persons to wonder if other senses than the ones we have might not have been possessed by some of our ancestors, and have become aborted through disease, or if new ones might not be developed by our successors in time, through the reaction of environment upon our organization. I think it was Sir John Herschell who remarked that there was room enough here for half a dozen senses, where now we are wholly without proper means for interpreting any within these limits.

It will be well to remark here that a great distinction must be made between the vibrations which can affect the organs of hearing and those which affect the eye. For the ear, what we call sound vibrations consist in the actual movements of masses of matter. A sound vibration is the to-and-fro motions of the air molecules, if the sound be in air, the motions being in the line of the movement of the air wave; tnat is, longitudinal vibrations. The air particles act upon the tympanic membrane and cause it to move to and fro at the same rate. The execution of the membrane is exceedingly small, estimated by Lord Rayleigh to be .0000081 millimetre for the sound of a whistle at a distance not too great to be heard. As for the range of hearing it is commonly reckoned to be between 16 and 40,000 per second; but here it is needful to bear in mind that such upper limit is not so much due to lack of inability to hear higher sounds as it is to the difficulty in producing such high sounds having sufficient energy to affect the ear. The higher the pitch the less amplitude can be given to the vibrations, and presently a limit is reached, but it is a *mechanical limit, not a sensation limit.* Occasionally an individual is found with an abnormal ear structure, deaf to lower vibrations, but able to hear from 20,000 to 70,000 vibrations. It is probable that cats, mice and some insects can hear vibrations much beyond our common limit. Again for the lower pitch, when such a figure as 16 vibrations is set for it, all that it means is that 16 vibrations produce a *continuous sensation;* the individual vibrations are not heard apart. A single tap upon the table with the finger nail can be heard easily enough. There are some persons who can distinguish as many as 32 individual vibrations per second, and to such a one the lower limit will be above 32.

In general the young have a higher limit for these lower continuous sound-sensations than older persons. In my opinion if some mechanical means could be devised for putting more energy into the high pitch sounds we should be able to hear much beyond our present limit. This is the same as saying that our nervous system for hearing is not limited by the range commonly set for it. That is merely incidental.

As for the eye and the vibrations operative in them, that is a very different structure and different kind of a wave, and in a different medium. What we call light is a wave motion in the ether, and is a transverse movement, too. Molecules have nothing to do with it except to produce it. The waves of ether which affect the eye range from about 400 millions of millions per second to 800 millions of millions per second, the longest wave being what we call red waves, while the shortest is called violet, though it is well known that waves much shorter than those in the common spectrum can be seen by some eyes. It was the opinion not many years ago that there were different kinds of waves called light, heat and chemical or actinic waves, but that view is untenable, for every ray of every wave length will heat the matter it falls on, and every ray will produce chemical effects. All depends upon the kind of matter the waves fall on. Photographic plates are prepared with salts of silver, and it happens that such chemical substance is sensitive to waves about the 50,000th of an inch. Other chemical substances are sensitive to rays less than the 30,000th of an inch in the same way. The eye is sensitive to waves within the limits mentioned above because the molecular structure is of a definite sort. Let it be remembered that the effect in the eye is a photographic effect, and that the substance sensitive to light is secreted by the retina, and is bleached by the action of certain waves. Color-blind persons are generally less able to see the long waves called red than persons with normal eyes. This means that the limit to vision is fixed not by the waves but by the structure, the necessities being such waves as are capable of affecting chemical decomposition in such molecular structures as can be secreted by the eye itself.

Waves both longer and shorter than those called visible have been traced by Langley and others a long way beyond our spectrum limit. The spectrum below the red end is known to extend 12 or more times the length of the visible spectrum, and Abney is said to have photographed the whole length. This disposes of the notion of there being any such things as chemical waves as distinct from others. The same waves that produce the sensation called light will heat a piece of common matter if they fall on it, and will decompose some kinds of molecules if they fall on them.

Since Maxwell's and Hertz's work is conceded, that so-called electric waves possess all the characteristics of light, they are propagated with the same speed, can be reflected, refracted, double-refracted and polarized, made to interfere and produce stationary waves with nodes and so on. Such waves and nodes were produced and noticed by myself in 1881, but thinking they were obvious enough, and having other work in hand, I did not imagine them to have the importance others have attributed to them. They all show, however, that there is no lower limit to wave lengths in the ether. An electromagnetic wave produced once a second is 186,000 miles long; a wave to affect the eye is one 50,000th of an inch long, and soap bubble phenomena show waves much shorter.

The senses called taste and smell depend upon molecular contact of bodies, not upon vibrations. Particular kinds of molecules are necessary; for smell they generally are gaseous exhalations, for taste they are in solution; hence they are not to be considered in the range of vibratory motions. The rate of vibration of, say, molecules of ammonia, are the same in a bottle as in the air, if at the same temperature, but in the bottle they give no sensation because molecuar contact is essential.

The range in our sensations is apparently limited by the physiological structure, and if we are to receive the current doctrine of descent the structure has been largely determined by the mechanical and molecular energies which can react upon matter. I do not know of any vibratory form of energy between the mechanical ones we call sound, and on the to-and-fro movements of masses of matter, and the molecular and atomic ones that produce ether waves. One is an impact, the other an internal shiver.

In an artificial way so-called electric waves have been produced, having a length of about an inch which would give per second as many as there are inches in 186,000 miles.

$$186,000 \times 5,280 \times 12 = 11,784,960,000.$$

We have no nervous organization capable of being affected by these in a direct way. This does not mean such waves do not affect it, it means only that we have no specific means for noting them as we have for sound and sight. Such waves it seems likely would affect other kinds of organisms, but I do not know of any experiments that prove conclusively they do. There is a large field here for the study of the effects of waves of different periods on living things, and a few persons have begun to study them with such means as are at their disposal. We may look for interesting results.

Electrical Fountains at the Atlanta Exposition.

The officers of the exposition to be held in Atlanta, Ga., this fall, have accepted plans submitted by Mr. Luther Stieringer for a large twin electrical fountain, which will embody many novel features.

The site finally selected for the fountain is in the centre of the grand basin, opposite machinery hall, and for this location the plans of the designer were especially drawn. This site presents numerous natural advantages which have not been enjoyed by any prior fountains. When in position the fountain will be plainly observable from base to apex from almost every point on the exposition grounds, and the mirror effect produced by the reflection of the fountain in the waters of the lake will be of the most unique and beautiful description and constitute a distinctive feature never before realized at any of the great expositions.

Rising from the surface of the lake, the fountain structure containing the operating chamber will present the appearance of a half submerged rocky island of irregular form, having a length of 100 feet and extreme width of 50 feet.

The designs will include wheat sheaves, geysers, curtains and a mist bank which is a new feature in this class of work. To produce the various effects will require about 2,000 discharge orifices. Twenty-three arc lamps will be used, each of unusually high candle-power. Water will be supplied at 100 pounds pressure through a 16-inch main, the supply being handled by Worthington pumps having an aggregate capacity of 15,000 gallons a minute.

The Sensibility of Galvanometers.

BY W. M. STINE, PH. D.

There exists much uncertainty and confusion in the rating of the sensibility of various types of galvanometers. Many published statements of the sensibility of particular instruments can be shown to be both misleading and erroneous through the failure to conform statements to a proper analysis of the instrument in question.

The cause for this is not far to seek. The literature on the subject has been voluminous but far from thorough and comprehensive. Too much of it has been purely descriptive; and much of the mathematical analysis, where this has been attempted, has been directed toward particular phases of construction or operation, rather than a thorough-going analysis of the theory of the galvanometer. Chapter III., Kempe's "Handbook of Electrical Testing," may suffice as an example.

The best literature in English on the subject is Chapter IV., Vol. II. of Maxwell's "Electricity and Magnetism"; "Galvanometers," by Ayrton, Mather and Sumpner*, and "The Galvanometer," by Prof. E. L. Nichols†. To this list may be added a serial on the grading of coils for the Thomson galvanometer by E. F. Northrup‡ and several articles by F. L. O. Wadsworth§.

In the present article attention is called, not to theoretical considerations governing the construction, but simply to the proper rating of astatic and non-astatic galvanometers.

For the small needles of such galvanometers we have for the angular deflection θ

$$\tan\theta = \frac{C\,G}{F} \qquad (1)$$

providing the angle θ does not exceed the usual limit of 5 degrees. In this equation C denotes the current in amperes, and G is the magnetic constant of the coil within which the needle moves. F is the resultant controlling field of the earth and the adjusting magnet. Where the adjusting magnet is not employed,

$$\tan\theta = \frac{C\,G}{\mathfrak{H}} \qquad (2)$$

$\mathfrak{H}$ being the value of the earth's magnetic field.

The sensibility of a galvanometer is determined by the value of the deflection, θ, for a given current, or what amounts to the same thing, the current in amperes necessary to produce unit value of the deflection, θ. The latter method is the usual one for expressing the sensibility. Equations (1) and (2) also enable us to determine the conditions affecting the sensibility. For a particular instrument, G is necessarily constant and its value is determined by the construction, placing of the coils, the character of the magnet and its suspension as well. If the instrument is properly set up it follows that G is a constant and does not affect the variations of its sensibility in use. The quantities then varying the sensibility are F and $\mathfrak{H}$, and the influence of their variations is expressed by their reciprocals $\frac{1}{F}$ and $\frac{1}{\mathfrak{H}}$. To express the sensibility correctly, it is also necessary to give the absolute value of F or $\mathfrak{H}$ in dynes.

Variations in F or $\mathfrak{H}$ give rise to variations in the period of the system, the period being the time in seconds elapsing between successive passages of the index over the zero mark on the scale. The value of the period T is determined by the equation:

$$T = \pi\sqrt{\frac{I}{M\,\mathfrak{H}}} \qquad (3)$$

I, being the moment of inertia of the system and M, its magnetic moment. Both I and M being constants, the period T will vary as the reciprocal of the square root of $\mathfrak{H}$.

We have now data for the proper comparison of galvanometers in respect to their sensibility. The variables are T, F or $\mathfrak{H}$, hence it follows that relative sensibilities are accurate only when reduced to equal periods of swing of needle, and equal strength of the controlling field.

The Controlling Field.—It is apparent from equation (1) that, when the controlling field is weakened by the use of a control magnet, the current to produce unit deflection will decrease in the same ratio. From theoretical considerations it is possible to impart any desired degree of sensitiveness to a given galvanometer. Practically the sensibility can be increased only within rather narrow limits, owing to drift and lengthening of the period. This change in the sensibility is a matter seldom calculated, but determined rather by trial conditions governing the use of the galvanometer for a given purpose. Usage has ruled that the figure of merit assigned to an instrument shall be determined without the use of a control magnet. It is obvious that this furnishes the only basis for comparison. Stress should be laid on the fact that the sensibility of a galvanometer is not correctly stated unless the particular strength of the earth's field in which it was determined is mentioned. The writer has noted working variations in $\mathfrak{H}$ between .18 and 1.45 C. G. S. units.

The Period.—We will now investigate the influence of the period on the sensibility.

From equation (3) we find

$$\mathfrak{H} = \frac{\pi^2 I}{T^2 M},$$

by substitution for $\mathfrak{H}$ in equation (2)

$$\tan\theta = \frac{C\,G\,T^2}{\frac{\pi^2 I}{M}};\ \text{place}\ \frac{\frac{G}{\pi^2 I}}{M} = K,$$

and assign unit deflection value to tan θ; then

$$C = \frac{1}{K\,T^2}. \qquad (4)$$

In this equation K being constant, C and T are the variables with which we are to deal. As the current to produce unit deflection is lessened the period increases as the square of its ratio of decrease. The influence of variation in the controlling field may now be analyzed. If the field is decreased the current to produce unit deflection is lessened in the same ratio while the time of swing of the suspended system is increased by the square of the ratio.

Should the sensibility, C, of a galvanometer be expressed at a certain period, T, its sensibility, C', for any other T', will be thus determined

$$C' = \frac{C\,T^2}{T'^2} \qquad (5)$$

However, should the current be assumed constant the deflection D' for a period T' would be the reciprocal of the current relation, thus

$$D' = \frac{D\,T'^2}{T^2}. \qquad (6)$$

It is possible then to readily compare galvanometers if in addition to their sensibility the strength of the controlling field and the period be stated.

It will be noticed that this discussion makes no mention of the influence of the damping of the system on the time of a vibration. In some galvanometers it is so slight as to be negligible; in others, so great that the system is aperiodic in its oscillations. No system will repeat its amplitude of vibration indefinitely, but these will grow less and less until it comes to rest. The complete comparison of the sensibility of galvanometers must contain a correction for damping. To obtain the time, T_1 of the vibration of a system *free* from damping from an observed time, T_2, when damping is present, we have

$$T_1 = T_2\frac{1}{\sqrt{1+\left(\frac{\lambda}{\pi}\right)^2}}.$$

This factor of correction can be directly inserted in equation (6), since $T_1 = T'$,

$$D' = \frac{D\,T_2^2}{T_1^2}\,\frac{1}{1+\left(\frac{\lambda}{\pi}\right)^2} \qquad (7)\|$$

in which T_2 is the actual period of oscillation; T_1, the period free from damping; and T the standard period adopted for comparison. This equation applies to constant current galvanometers, with a suspended magnetic system; not to D'Arsonval or ballistic types.

$$\lambda = \log_e\rho = \frac{\log_{10}\rho}{.4343}.$$

The expression of the deflection imposes certain arbitrary standard conditions of measurement. It is assumed that the class of galvanometers here discussed are of the reflecting type, the scale readings being made either by a telescope or a beam of light. For comparison a unit of deflection and a unit scale distance from the mirror must be agreed upon. Both custom and convenience have dictated that deflections be expressed in millimetres at a scale dis-

* *Philosophical Magazine*, July, 1890.
† *Electric Power* (serial), 1894.
‡ ELECTRICAL WORLD, November and December, 1893.
§ *Philosophical Magazine*, 1894.

‖ The correction for damping requires the determination of λ, the logarithmic decrement. This may be defined as the logarithm of the ratio of the amplitude of one oscillation to that of the next following. On a scale reading right and left of the zero to which the system has been adjusted at rest, an oscillation is the sum of the succeeding right and left deflections.
See "Maxwell's Electricity and Magnetism," Vol. II., pp. 378 and 381; also "Practical Electricity," Ayrton, pp. 296 and 297.

tance of one metre. A further convention has been adopted to express the current for unit deflection. Since the current is so small its order is always denoted by the negative powers of 10. In this way the exponent of 10^{-11} has come to denote the order of sensibility of the galvanometer. The constants furnished by some makers as well as published statements are often misleading in that they assign a higher value to the exponent by the extension of the numerator of the fraction. The degree of sensibility is denoted by the negative exponent, and its units position in that degree by one figure followed by a decimal. For example, 685×10^{-11} and 6.85×10^{-11} would conventionally indicate the same degree of sensibility when it is evident the second instrument is 100 times the more sensitive. This convention does not involve the accuracy but the convenience of the above results. Usage has decreed that these sensibilities should read 6.85×10^{-9} and 6.85×10^{-11}.

When galvanometers are used for the purpose of insulation testing, it is more convenient to express sensibility in the number of megohms through which one volt will produce unit deflection.

English makers are especially lax in the designation of constants. Occasionally one sees a galvanometer whose constant is given as so many megohms for one division with one Daniell's cell, at a distance of 35 inches, or 43 inches. Such a constant is useless unti it has been reduced to rational dimensions. In the first place the scale division is some arbitrary unit adopted for that particular scale. The Daniell cell leaves one open to the doubt whether the voltage correction is 1.05 or 1.08 or some iutermediate number, depending on the condition of the particular cell used. The odd scale distance is due to the use of concave mirrors and necessitates a correction. Nor is mention even made of the value of $\mathfrak{C}$. The plea is that a galvanometer is invariably calibrated before using it, hence the constant need only be approximate. But the maker's constant is often the actual basis of comparison and purchase, and is besides the only means for obtaining data for the time constancy of the instrument. In short a galvanometer constant should be as accurately expressed as if the instrument were a standard volt or ampere meter.

In Table I. a list of galvanometer constants is given. It has been compiled from manufacturers' certificates and published accounts of galvanometers. Columns three and four show the sensibilities corrected to standard conditions. In no case has the control strength, $\mathfrak{C}$, or the correction for damping been given. The results expressed have no scientific value, and are only given as examples of a common error.

Table II. was compiled merely for comparison of the four instruments contained in it. As these measurements were made simultaneously on instruments mounted near each other, it may be assumed that $\mathfrak{C}$ was constant for the four. The table is given as an exhibition of the influence of the correction factor for damping. In both tables the data were obtained without the use of a control magnet.

TABLE I.

Column.	1.	2.	3.	4.	5.
Galvanometer.	Type.	Current, as stated.	Current, standard.	Megohms, standard.	Resist'nce, ohms.
A	4-coil astatic.	4.0×10^{-11}	4.0×10^{-11}	25,000	86
B.	8-coil astatic.	271×10^{-13}	2.71×10^{-11}	36,900	12,664
C.	4-coil astatic.	388×10^{-13}	3.88×10^{-11}	28,360	6,302
D.	4-coil astatic.	535×10^{-13}	5.35×10^{-11}	18,670	5,827
E.	D'Arsonval.	118×10^{-9}	1.18×10^{-7}	8,450	234
F.	Ballistic	169×10^{-11}	1.09×10^{-9}	.....	9,295
G.	4-coil astatic	12×10^{-11}	1.2×10^{-10}	.....	5.123
H.	2-coil astatic (?)	398×10^{-11}	3.98×10^{-9}	.....	393

TABLE II.

Galvanometer.	Not corrected	Corrected for damping.	Resistance ohms.	Damping.
I.	1.25×10^{-10}	1.15×10^{-10}	10,150	Very great.
J.	1.66×10^{-10}	1.66×10^{-10}	10,200	Very slight.
K.	5.0×10^{-10}	1.92×10^{-10}	9,590	Nearly aperiodic.
L.	8.34×10^{-10}	8.34×10^{-10}	10,000	Very slight.

From the Frying Pan into the Fire.

In a patent recently granted for an electrical motor, the inventor dispenses with the necessity of the "troublesome commutator" by substituting for it a make-and-break device through which the whole current flows!

On Certain Effects Produced by "Distributed Capacity" in Wire Coils.

BY A. S. KIMBALL.

Several important papers have been published recently on the phenomena which depend upon the electrostatic capacity of closely wound coils of wire.

These papers have made it perfectly evident that no electrical measurement in which impulsive or alternating currents are employed can be accepted as beyond question until careful investigation has shown that all possible "capacity effects" have been eliminated or allowed for. An examination of some of the phenomena referred to was undertaken last summer at the Worcester Polytechnic Institute by members of the graduate class in electrical engineering, and the work has been continued at intervals by the help of several students to the present time.

Some of this work has been duplicated elsewhere, and confirmatory results have been recently published. This may be passed without notice, or mentioned only because the quantitative results obtained have a value. It is not easy to define the capacity of a coil, but it is readily seen that when E. M. F. is applied to the wire, its potential varies from element to element, and consequently a charge is accumulated. When an alternating E. M. F. is employed there is an alternating charge and discharge, giving rise to an alternating "capacity current."

As a matter of convenience we may consider such a coil replaced by a system of two branches, one of which contains the resistance and inductance of the coil, but does not possess capacity, the other containing a condenser in series with resistance, or resistance and inductance.

The current in the first branch may be called the "coil current," and is that which would flow if the coil had no capacity.

That in the second branch may be called the "capacity current," and has such a phase and magnitude as will give when compounded with the "coil current," the current in that part of the circuit external to the system.

It will be noticed that this hypothesis makes the system equivalent to the actual coil only in respect to the one fact that it may be substituted for it without changing the phase or magnitude of the external current. An equivalent system which would replace the primary coil of a transformer, for instance, not only in its effects upon the external circuit, but also in its effects upon the iron core, may be very unlike the one proposed. Indeed, such a simple system would be impossible, but it may be remarked, however, that although the equivalent capacity may be very different from the distributed capacity of the coil, it is the existence of this latter which makes the former necessary in an equivalent system.

The experiments which follow will illustrate these remarks more fully:

[Expt. 1.] The coil used in this experiment was of No. 36 German silver wire, wound "non-inductively," and saturated with paraffine.

Its resistance was approximately 100,000 ohms. The alternating current employed was taken from a Westinghouse generator running at a speed which gave 121 complete periods in a second.

The circuit was formed by putting in series a variable resistance, an electrodynamometer, and the coil of wire under examination in parallel with a Kelvin electrostatic voltmeter. The potential difference at the terminals of the coil was adjusted to a convenient amount and the current measured. A suitable number of storage battery cells was then substituted for the alternating-current generator, and the experiment repeated with the same potential difference at the terminals of the coil.

The results obtained from two sets of readings are given:

P. D. on the Coil.	D. C. Amperes.	A. C. Amperes.
190 volts.	.00189+.	.00640—.
247 "	.00246+.	.00821—.

The alternating current through the coil in each case being about three and one half times as large as the direct current with the same E. M. F.

The instruments used were calibrated in position several times during the experiments, through the whole range of readings employed, by comparison with standards of known accuracy. In some of the earlier experiments with this coil alternating currents from other sources were used, and while the results obtained were not so carefully checked as those given above they have a certain

interest since they show the effect of a variation in the number of alternations. No. 1 generator had a "smooth-core" armature, and ran at a speed which gave 121 complete periods. No. 2 had an "ironclad" armature, and ran at 129 periods. No. 3 was a direct-current bipolar machine, with collecting rings for alternating currents, and gave 21 periods.

The results with No. 1 have been given. No. 2 gave with 223 volts a current of .0078. No. 3, with 103 volts, gave a current of .00145. The apparent resistances of the coil being approximately as follows:

With *D. C.*	100,000 ohms.
" *A. C.* 21 periods.	71,000 "
" *A. C.* 121 "	30,000 "
" *A. C.* 129 "	28,600 "

[Expt. 2.] The coil used in this experiment was about 20 inches in diameter. Two No. 36 German silver wires were wound side by side in a channel a little more than ¾ inch wide until the radial depth of the wire was about .08 inches. The number of convolutions (both wires) was 588. Each layer was paraffined as it was wound and measured with care. The approximate value of the coefficient of induction computed from the measurements was $.369 \times 10^9$. The resistance of the coil was about 22,500 ohms. The insulation resistance between the two wires was nearly 50 megohms.

Its capacity was measured between the two coils by comparison with a .5 M. F. mica condenser. For a short charge it was found to be .024 M. F., after 60 seconds charge .060 M. F.

The ends of the two wires could be joined "inductively" or "non-inductively."

Similar measurements to those described under Expt. 1 were made with this coil. The applied E. M. F. was 200 volts in each case, and the alternating current employed was from generator No. 2—129 periods. The following results were obtained:

With the direct current, .00905 amperes.

With the alternating current, wires joined "inductively," .00940 amperes.

With the alternating current, wires joined "non-inductively," .00972 amperes.

In this experiment as in the former we see that the alternating current through the wires joined "non-inductively" is larger than the direct current with the same E. M. F., while the alternating current through the wires joined "inductively" lies between these two values, this result was what we should have expected from the small value of $\frac{Lp}{R}$.

If we compute the coefficient of self-induction from the results of our experiment with the wires joined "inductively," on the supposition that the coil has no capacity, we shall have from the formula

$$C = \frac{E}{\sqrt{R^2 + L^2 p^2}}$$

the value of $L = 7.5 \times 10^9 \times \sqrt{-1}$, an imaginary quantity which we might call negative inductance.

The value of L computed from the dimensions of the coil was $.329 \times 10^9$.

To check the results given by the instruments used in these experiments the current and E. M. F. at the terminals of a .5 M. F. condenser by Elliott was observed and its capacity computed from the formula

$$\text{capacity} = \frac{C}{2 \pi n E}.$$

The results thus obtained did not differ by more than 1 per cent. from the rated value of the condenser.

[Expt 3.] The coil used in Expt. 1 was placed in the circuit of dynamo No. 3, and the phase angle between the resultant current and the applied E. M. F. was measured. The current was found to be 20 degrees in advance of the E. M. F. This angle, the value of the resultant current, the resistance, and the applied E. M. F., afford sufficient data for the computation of the resistance and capacity of the second branch of an "equivalent system." These quantities were $R = 17{,}000$ ohms and $K = .06$ M. F.

[Expt. 4.] The coefficient of self-induction of the coil used in Expt. 2, was measured by comparison with a resistance using the method proposed by Rayleigh. The computed value of L was $.329 \times 10^9$. The experiment gave $L = -7. \times 10^9 +$ the value varying with the resistances employed in the branches of the bridge.

An analysis of the problem involved in this experiment will show that the results given by the usual formula are incorrect when the coils in the arms of the bridge are paralleled by circuits containing capacity. In this case a correction term must be introduced, positive for two arms, negative for the others. When the capacity circuit has no resistance save that of the condenser employed, the value of the correction term is equal to the capacity multiplied by the product of the resistance of the bridge arm in question into the resistance of the coil whose self-induction is to be measured. If, as in the present case, the resistance of the tested coil is high, the correction for this arm may dominate the result and change its sign since this correction is negative.

On the supposition that the result obtained was wholly due to a condenser in parallel with the coil whose inductance was measured, we find that the capacity of the condenser must be about .02 M. F., a result which agrees quite well with that obtained in Expt. 2.

[Expt. 5.] A coil of copper wire was wound whose radius was 15 cm. $R = 35$ ohms. $L = .09 \times 10^9$ (approximate measurements).

The value of L given above was computed from the dimensions of the coil.

L was then measured by the method of Expt. 4, using as ratio coils in the different groups 100 : 100, 10 : 10, 1,000 : 1,000, 100 : 1,000 and 1,000 : 100. The error of every coil in the box was known to $\frac{1}{20}$ of 1 per cent.

A comparison of results shows that the measurements in the same group agree quite closely. When coils 100 : 100 were used the results differed from each other by less than one fifth of 1 per cent., and the mean was very near the computed value.

Some of the groups gave averages above, others below the computed value. The greatest divergence was about 3½ per cent., and the extreme values in this group differed from each other by nearly 1 per cent. These divergences are evidently due to the "distributed capacity" of the arms of the bridge, and verify in each instance the deductions given under Experiment 4. When the resistances employed are small, and the ratio coils are equal to each other, the effect of distributed capacity may be neglected unless extreme accuracy is desired.

[Expt. 6.] The work of the "leakage current" in a 40-light Westinghouse transformer was measured by the three-voltmeter method, using in the first place the secondary, then the primary coil.

The applied E. M. F. was adjusted in each case to secure the same induction (on the assumption that this is determined by the voltmeter reading and the dimensions of the transformer core and coil), and, therefore, the same hysteresis and eddy current loss. After correction for the resistance of the wires the result obtained on the primary side was 22 per cent. less than that given by the secondary. Measurements on other transformers gave similar results varying from 20 to 30 per cent. While this experiment does not prove that the whole difference obtained was due to distributed capacity, the result is what would have been obtained if in these measurements a condenser of a few hundredths of a microfarad had been shunted on the terminals of the secondary coil.

These results suggest the possibility of winding the primary of a transformer in such a manner as to diminish still further the so-called "leakage current," and a choking coil was designed and constructed to test this point.

[Expt. 7.] The core of the choking coil referred to was a bundle of very soft iron wire about ¾ inch in diameter.

The length of the closed magnetic circuit was not far from 24 inches. The core was wound with 10,000 convolutions of No. 24 wire in ten seconds. Two wires with 500 convolutions each were wound together in a section.

The two wires in each section were marked A and B, and the sections were numbered from 1 to 10.

For the first group of experiments the wires were joined in series in the following order: A_1, B_1, A_2, B_2, etc., to A_{10}, B_{10}. For the second group the order was A_1, A_2, A_3, etc., to A_{10}, B_1, B_2, B_3, to B_{10}. The applied E. M. F. was adjusted to 55 volts in every measurement.

With the usual distribution of E. M. F. on the coil it is evident that the potential difference between contiguous elements of the A and B wires will be 2¾ volts in the first group, and 27.5 volts in the second. Therefore, the "capacity current" should be larger in the second than in the first, the "coil current" remaining the same. The apparatus was designed so that the hysteresis and eddy current work should be relatively small, the lag angle between 80° and 90°, and the resistance of the wire about 300 ohms.

Under these conditions the current in second group of measurements should be considerably smaller than that obtained from the first group. Upon measurement the second current was found to be 78 per cent. of the first.

These experiments are sufficient to show that "distributed capacity" in coils of wire is a possibility which must be taken into account even in some of our ordinary electro-technical measurements. They also suggest several desirable subjects for investigation.

Certain preliminary measurements already made seem to promise curious, if not practically important, results and the work will be continued as opportunity offers.

Notes on the Reconstruction of a Small Central Station Plant.*

BY FRANKLIN L. POPE.

The financial condition of the smaller central station electric lighting plants throughout the country is at the present time by no means satisfactory, and in too many instances cannot even be truthfully said to be encouraging. A survey of the field shows that very few such plants located in towns having less than 10,000 inhabitants are earning more money than is necessary to meet their operating expenses and to provide for indispensable current repairs. In the State of Massachusetts, in which the operations of all electric lighting companies are by law made a matter of public record, it appears from the latest reports that the aggregate liabilities of the 57 companies operating in that State, including stocks, bonds, and floating indebtedness, amounted on June 30, 1894, in round numbers to $14,000,000, nearly all of which stands charged to construction account. The net earnings for the preceding year were $1,000,000, or about 7.1 per cent. on the total investment; a sum obviously quite insufficient to provide for depreciation and at the same time pay a fair dividend on the capital which has gone into the business. But if half a dozen of the larger plants, in cities like Boston, Lowell, Worcester, Springfield, Lynn and Fall River were excluded from the list, the showing for the smaller plants would be even far worse than it now appears.

Many of these small plants were started at an earlier day than could have been justified by any reasonable estimate of the business then in sight, and now find themselves hampered by inconvenient buildings, and with unsuitable machinery, bought at high prices, and encumbered with defective business methods which experience has shown to be wholly inconsistent with the dictates of good judgment.

With the owners of many of these plants, it has become a very serious question whether the easiest way out of the dilemma which confronts them may not be to relegate the entire plant to the junk-shop and the scrap-pile, and commence over again with new buildings, modern machinery and improved methods of administration. When the necessary capital is readily forthcoming, there can be no doubt that this would often be the wisest course of procedure, but for obvious reasons, it is one which is not always, nor even usually practicable. The alternative is to remodel the existing plant, bringing it as nearly as may be into accordance with the best modern practice, and utilizing so far as possible the old material; a course which at least has the merit of avoiding an undue expansion of the construction account, in most cases already sufficiently burdensome.

Having been called upon during the past year to advise the owners of a plant of the character above referred to, in reference to certain changes which had been suggested as desirable, and having afterward been employed in a professional capacity to design the work and superintend its execution, I have thought that some account of what we undertook to do and how we did it, might not be without interest to the members of the Institute.

The Great Barrington (Mass.) Electric Light Company was organized and commenced business in 1888. The population of the district intended to be served was about 3,000, and most of the expected consumers were located within 2,000 feet of the point decided upon for the station. This was built of wood, in the most inexpensive manner possible, and was placed alongside the railway for convenience in receiving coal, although at the same time the danger from fire was materially increased. The original outfit was an Edison 3-wire, equipped with a pair of 250-light 110-volt dynamos, and the company commenced business with 281 lights on contract at $10 per year each; wiring free. The centre of distribution was 1,800 feet from the station, necessitating over a ton of copper in the feeders alone. Generally speaking, the plant was well laid out, and well built as things went in those days. The two dynamos were belted to a single 80-hp Armington & Sims engine. The original cost of the plant was about $16,000. The following year a Schuyler arc plant for street-lighting was added, carrying 35 arcs, nominally of 1,500 cp, which was run from the same engine and boiler. In 1890, the plant was considerably enlarged by the addition of a second arc machine, a Westinghouse 500-light alternator, and a second engine and boiler of the same capacity as the first. An 80-kw Westinghouse dynamo of more modern type was afterward substituted for the original one.

Upon examining the plant last year, I found the Edison machines carrying on Saturday evenings a maximum load of some 450 lights, while three evenings in the week (with the stores closed) it fell to perhaps half that amount. The two Schuyler machines, with an aggregate capacity of 55 to 60 lights, were carrying about 38 to 40, or an equivalent of that amount, while the Westinghouse machines was seldom as much as half-loaded, carrying a maximum of possibly 500 lights during three or four months of the summer season, and not much more than one fourth that amount the remainder of the year. Necessarily, with so many dynamos of different types, and with such a variable, yet small average output, the consumption of coal was excessive as compared with the light delivered and paid for.

The street lines, according to the usual practice, were of No. 6 B. & S. weather-proof wire; the poles were of cedar, of good size and fitted with pine or spruce cross-arms, with common green glass insulators set upon wooden pins. In consequence of a silly prejudice, which had been fomented among the citizens by interested parties against permitting poles to be set in the streets, the wires, in a very great number of instances, had been attached, by cross-arms or brackets, to the trunks of the immense elm trees with which the streets of the town were shaded; a practice which occasioned an enormous loss of current every wet night, as well as much irregularity in the performance of the lights. The effect on the trees was by no means salutary, while the appearance was as much worse than that of poles in the streets as could possibly be imagined.

The village of Great Barrington extends for the most part along a single broad thoroughfare for a distance of nearly three miles, and the street-lighting circuits are consequently very straggling. The 1,500-cp lamps, which were suspended at intervals of 800 to 1,000 feet, were actually of very little service in illuminating the densely shaded streets.

After a careful consideration of the situation, keeping in view the greatest possible reduction of present and future operating expenses, it was determined the wisest course to pursue would be to consolidate the whole service so that it could be supplied by one dynamo, in place of five underloaded ones. In pursuance of this plan it was decided to adopt the two-phase alternating system, at a maximum pressure of 2,100 volts in the primaries, and 105 volts in the secondaries, with a frequency sufficiently low to permit the advantageous use of induction motors if required. It was furthermore decided to abandon the steam plant, and to make arrangements to utilize some one of the excellent water-powers which were available within practicable distances. Under ordinary circumstances, I should have hesitated to recommend the substitution of water-power for steam as the sole source of power for the operation of an electric-lighting plant. Water-power is an invaluable auxiliary, and when conveniently available for use in conjunction with steam, may often be made to save a very large coal bill in the course of a year. On the other hand, the excessive fluctuations to which it is subject—which are scarcely realized by those but casually acquainted with the subject—render it in most cases a very uncertain reliance for a business which is compelled to go on, perforce, every night in the year, and which cannot suspend operations, as an ordinary manufactory does, if worst comes to worst, for a week or two at a time. Even a water privilege which, during 10 months of the year, furnishes twice as much power as is needed, and even more, may be expected to fall off, during one of the extraordinarily dry seasons which occur at intervals of from five to 10 years, to one third its usual amount. In such a case, an electric plant solely dependent upon water-power would find itself in a most undesirable predicament.

In the present instance, the choice of a water privilege finally reduced itself to two sites, one in the town itself, within half a mile of the centre of consumption, and the other at Glendale village, seven miles distant, both situated on the Housatonic River. The privilege first mentioned being already occupied by a woolen factory, only the surplus water was available, but this was known to be quite sufficient for the requirements of the electric company at least nine months in each year, leaving three months to be run

* A paper, slightly condensed, presented at the Twelfth General Meeting of the American Institute of Electrical Engineers, Niagara Falls, N.Y., June 27, 1895.

by steam. It had the advantage of being close at hand, and was capable of being fitted up at a moderate cost. As to the Glendale privilege, it was necessary to be very sure that the lowest water of a dry summer would give all the power required to run the plant without the aid of steam. Having invariably found the value of a water-power to be greatly exaggerated, not only in popular estimation, but in the opinion of its owners, the matter was investigated with much care.

While negotiations were still pending with the owners of the Glendale privilege and also the one in the village already referred to, overtures were received from a manufacturing company owning a third exceptionally desirable privilege, on the same stream, at an intermediate point considerably nearer than Glendale. This company had only recently completed a new dam, head-gates, raceways, etc., at a very considerable expense, and was willing to lease the complete establishment, including a new McCormick turbine of 325 hp and a two-phase Stanley generator of corresponding capacity, at a monthly rental based upon the actual output as measured in kilowatt-hours at the dynamo terminals, provided that a certain minimum monthly consumption was guaranteed. With the same volume of water as at Glendale, the fall at this point was 20 feet, assuring at least 417 hp at lowest water, during lighting hours. All the hydraulic apparatus and appointments were of the best possible construction, and well calculated to insure absolute permanency of operation.

The minimum rental exacted was somewhat less than the amount of the coal bill of the Great Barrington company for the preceding fiscal year, but while the immediate saving in operating expenses was not large, the acceptance of the proposition would place the company in a position to reduce its rates to consumers, for the reason that its output might be very largely increased without materially augmenting its operating expenses. A lease for a term of years was accordingly closed.

In laying out the plant it was determined to bring the main feeders directly to a distributing station in the village, to be used principally as a convenient headquarters for testing the circuits and controlling the street-lighting service. In laying out the transmission line, a surveyor was employed, and a preliminary line was run directly from the power house to the distributing station. The air line distance was found to be 5.15 miles. With the assistance of the surveyor, the actual line was then staked out, going directly across country, and keeping as near as circumstances permitted to the transit line. About half the distance, the transit line was found to so nearly coincide with existing highways, that the consent of the local authorities was obtained to set the poles along the highway location; the remainder of the route lay principally through uncultivated land of little value, so that a comparatively small expenditure was sufficient to secure a release from all claims for land damages. This enabled the line to be located with long stretches absolutely straight, avoiding all sharp angles; a very important consideration when heavy wires are used. The poles were of selected chestnut with natural butts, usually set five feet in the ground at maximum intervals of 125 feet. The poles were ordinarily 25 feet long and eight inches thick at the small end. Shorter poles were sometimes used on elevations and longer ones in depressions, in order to equalize the strain as much as possible. The insulators used were of the large double-bell white porcelain type (German government standard), and were imported by us from Hagen. The insulator of the top wire is set upon a malleable iron stem 14 inches long, screwed into the top of the pole, which is tapered to five inches diameter and protected from splitting by driving on a wrought-iron ring. The tapered part of the pole, as well as the top, was given a coating of mineral paint mixed as thick as it could be spread with a brush. The insulator of the second wire is carried on a malleable iron goose-neck, screwed in a five-eighths inch hole bored in the side of the pole, in such position as to bring the wires about 16 inches apart. Another hole was bored on the opposite side of the pole, intended to take the goose-neck of the third wire at some future time, leaving the same interval between the second and third wires. The porcelain insulators are fixed to their iron supports by a packing of oakum placed between the screw-threads, which serves to prevent any danger of fracture by expansion or contraction. The line wire is laid in a groove formed in the top of the insulator, except upon the curves and angles, in which case it is tied at the side in a circumferential groove, as is usual in this country. The German method of tying is quite complex, and unnecessarily strong; in case of undue strain, if anything gives way it had best be the tie wire. We therefore devised a simple tie which was easily and quickly applied, and which has so far served an admirable purpose. We were obliged to string the wires during very cold weather; sometimes as cold as eight or 10 degrees below zero, and hence it was necessary to strain them very tight. A block and fall and a well-trained horse were used in pulling up, usually, six or seven spans of one wire at a time. The hook of the block was always attached to the copper wire, whether bare or insulated, with a chain-knot made of three-quarter-inch rope. The feeder wires were of No. 3 B. & S. soft copper, covered with weather-proof "insulation" along the highway (as a concession to enlightened public opinion), but elsewhere bare. The lengths of wire were joined with McIntyre twisted couplings; the unusual strain we had to put upon them occasionally pulled one apart, and this led us, out of abundant caution, to solder them, although this was done for mechanical rather than for electrical reasons. Only two feeder wires have as yet been strung, providing for a single-phase current from one side of the two-phase generator, but it is the intention to run a third feeder at an early day, which will enable two-phase induction motors to be connected to the same distributing system.

A pair of telephone wires of No. 12 steel were strung below the feeder wires, and these were supported upon small German porcelain insulators on iron goose-necks on opposite sides of the poles. These wires were transposed at intervals of about a mile, in order to eliminate the inductive effects of the alternating current in the feeders. The feeder lines were carried under the railway at an undergrade crossing by placing the insulators upon iron brackets leaded into the stone abutments. The plan of construction above described makes a strong, handsome and durable line, while the insulation of the circuit, even in the worst of weather, is simply faultless.

The system has been planned to deliver the current at the distributing station at a uniform pressure of 2,100 volts. Two distributing centres were fixed upon in the old Edison three wire network, and at each of these points a pair of large transformers, having a ratio of 20 : 1 were fixed upon a pole, with their respective primaries in series between a pair of branch feeders from the distrib uting system, and their secondaries were coupled in series in like manner, with the neutral wire between them. None of the consumers on the old Edison system knew when the change had been made to the new service from anything they were able to notice in the behavior of the lights.

The next thing done was to reconstruct the street-lighting system. In place of the 36 arcs of 1,500 nominal cp formerly in use we substituted 126 incandescent lamps of 50 volts and 32 cp, placed in Iona fixtures projecting horizontally from the poles 14 feet above the ground. The lights, as a rule, were fixed upon every alternate pole, but in the business centre, the street being broad, they were placed on each side at intervals of about 250 feet, and staggered, so as not to come opposite each other. A Shallenberger shunt cut-out was applied to each lamp. The usual number of lamps in each circuit was 42, although we have since placed, in some cases, as many as 47 in one series without reducing the brilliancy of illumination sufficiently to be noticeable by any one but an expert. One end of each street-lighting circuit is joined to a special feeder leading to the sub-station, where it is connected with the main feeder though a knife-switch. The other end of each lamp-circuit is connected to any conveniently located branch feeder of the regular commercial lighting service. Each lamp-circuit has, or will have, a fuse-block and cut-out inclosed in a weather-proof box at each end, where it joins the opposite feeders. These 32-cp lamps, when run at full candle-power, furnish a most satisfactory illumination, and give the streets a very attractive appearance. So far as possible, each lamp was located with the aid of a transit and level, so as to get them in absolutely straight lines both vertically and horizontally, a precaution which adds materially to the decorative effect. It is admitted by all that the streets of the town are much more satisfactorily lighted by the incandescents than they formerly were by the arc lamps, while the actual cost to the company is considerably less. The new lamps were cut in, one at a time, on the old arc wires, jumpers being temporarily placed across the terminals until everything was in readiness to discontinue the use of the arc-light machines.

One of the most marked advantages of the series street-lighting system, especially when shunt cut-outs are used, is its great flexibility and convenience. For example, instead of placing from 40 to 45 50-volt lamps in one series, we may use 20 to 23 100-volt lamps, or if an odd number be required, less than is necessary to

make up a circuit, the deficit may be supplied by adding extra shunt-boxes in series at any convenient point in the circuit, until the pressure has been reduced to the required point. From time to time, as new lights are added, these spare shunt-boxes are one after another brought into use in connection with them. Sometimes, also, we temporarily install extra street lights by connecting them in parallel to the secondary mains of the regular commercial service, ultimately transferring them to new series circuits.

It has been found to be desirable to use a lamp of rather low efficiency for the street-lighting service, as there is always danger of leakage and short circuits from wet boughs of trees and other objects getting into contact with the wires, and thus diverting an abnormal current through some portion of a lamp circuit. In such case, a lamp of high efficiency is pretty certain to be burned out, or at least to have its career of usefulness materially abridged. In this plant, the average consumption of energy in the street-lights, including lamps, lines, shunts and leakage, is found to be about 140 watts per lamp of 32 cp.

Perhaps the most ticklish part of the whole undertaking was the changing over of the Westinghouse system, which was a 1,050-volt primary and a 52-volt secondary, running at 16,500 alternations. In accordance with the new plan, it was of course necessary to double the pressure both in the primary and secondary circuits, and to substitute 104-volt for 52-volt lamps throughout. A preliminary test of one of the transformers demonstrated, that which perhaps might have been foreseen from theoretical considerations, viz., that a dangerous quantity of heat was developed within a few hours when it was used to convert from 2,000 volts down to 100. In order to utilize, so far as possible, the old transformers, and at the same time avoid the above difficulty, various expedients were resorted to. Wherever a group of consumers was located in one neighborhood, a pair of large transformers was installed, with secondary mains extending from 500 to 600 feet in various directions, these transformers being of course placed in series with each other. Scattering consumers as far as practicable were united in pairs or small groups, and supplied by a pair of small transformers coupled in the same way. The Westinghouse meters, having been originally constructed for a frequency of 16,500 alternations, ran slow when the frequency was reduced to 8,000. The necessary coefficient for correction of the readings was easily ascertained by experiment, and as fast as possible the meters were fitted with new discs, supplied by the Westinghouse Company at a trifling expense, adapted to the lesser frequency.

Of course it will be understood that the reason for resorting to these various shifts and expedients, was merely that we might utilize the old apparatus as far as it could possibly be done, and also that we might carry on the work of reconstruction, for the most part, with the ordinary force of the establishment.

The selection of the best among the many available types of turbines for electric work is a matter which merits far more consideration from a scientific standpoint than it generally receives. Water-wheels, like dynamos and motors, are sometimes sold on commission by agents, and it not infrequently happens that the salesman who makes the largest "claims," especially if he sells his goods the cheapest, carries away the contract. It needs to be said, however, that there is a far greater difference than is often suspected, in the work that different types of wheels will do with a given, and especially a limited amount of water. There are, furthermore, a great many types of wheels in the market, which although as efficient as could be asked for with a full head of water, are very far from being so when the volume of water is reduced, even by a comparatively small percentage. It is but just to say that it is seldom that a turbine makes so favorable a showing, not only in this but in other respects, as the one provided by the company from which we lease our power.

The results of tests made in the testing flume of the Holyoke Water Power Company are worthy of particular note, for the reason that they show a very high percentage of efficiency maintained through a wide range of variation in the quantity of water passing through the wheel; a most valuable characteristic for electric work. When the quantity of water used was diminished from 81.75 to 42.55 cubic feet per second, the percentage of efficiency fell only from 80.99 to 63.9, and what is even more remarkable, it was found that the efficiency remained well above 80 per cent. over a range of variation of discharge from 83.22 to 70 cubic feet per second, or 15.9 per cent. More than one type of turbine which enjoys a high reputation and extensive sale among power-users, will not reach 65 or even 60 per cent. efficiency at "three-quarters gate," while the 33-inch wheel above referred to has been found to give by actual test no less than 78 per cent. under similar conditions.

The turbine carries upon its shaft a driving-pulley 100 inches in diameter, weighing 1,000 pounds, which serves as a balance-wheel. It is also provided with a Replogle electric governor, operated by three cells of gravity battery, which has never failed to do its work quickly and certainly, even under trying conditions.

In carrying out this work, some things have been learned by experience which may be of use to others called upon to advise or to undertake the construction of similar works, and I will therefore venture to summarize some of my conclusions as follows:

1. In considering the advisability of operating an electric plant by water-power, do not on any account neglect to ascertain from authentic sources of information, just how much water can be depended upon during the low stage in an extra dry year, for this is the measure of its value for electric work, except when used as an auxiliary to steam. The ordinary estimates of the commercial value of a water-power are only too apt to prove preposterous exaggerations.

2. If rights-of-way or releases of damages can be obtained without too much trouble and expense, it is better to build the feeder line as directly across country as may be, than to follow a highway. The saving in cost of construction will usually be more than enough to pay for the right-of-way, and on such a route there need be no interference from trees, while many inconvenient angles and much trouble in guying and bracing are avoided. Shorter and stouter poles may also be used; in itself a very important consideration.

3. In electric line-construction it is preferable to dispense with cross-arms unless there are more than six wires. The best arrangement is to place one wire on a top-pin and the others alternately on the front and back of the pole, at a vertical distance apart of 12 inches. This construction not only costs less than properly braced cross-arms, but is much less conspicuous and therefore much less objectionable in a public street, is less interfered with by trees, and is far more durable. Much trouble is caused by the decay of cross-arms after they have been exposed a few years to the weather; they split at the ends so that the pin come out, and not infrequently break in two in the middle, thus fouling the wires.

4. In medium-sized towns and cities, especially in shaded streets, the incandescent lamp may be made to give a far better distribution of light for the same money than is possible with the "half-arc" so extensively used, and is much less troublesome to maintain in good working order. My own experience leads me to think that the lamps ought not to be of less than 24 or more than 32 candle-power. Use lamps of low rather than high efficiency, but run them at full candle-power, or even a trifle above. Good street-lights, well arranged, and renewed sufficiently often, are the best possible advertisement for any electric company.

5. Use large transformers as far as practicable, placing the consumers within 500 or 600 feet radius upon secondary mains. We have used both two-wire and three-wire mains. The latter plan is certainly to be recommended when the distance approximates or exceeds 500 feet, but for short distances, as for example when distributing within a single block at a pressure of 100 volts or more, it is a question whether the gain in cost of copper over the two-wire plan is of sufficient importance to offset the additional complexity.

6. It was found that raising the voltage in the residence district from 1,000 : 50 to 2,000 : 100 greatly improved the uniformity of distribution, by lessening the potential drop without entailing any corresponding disadvantages. It would seem to be preferable, on every account, to use the higher pressure.

7. One of the most important minor points in the management of a plant is apt to be too much neglected; the maintenance of the insulation of the wires by promptly replacing all cracked and broken insulators, and by keeping the wires absolutely free from contact with uninsulated objects. The covered wires which lead into the hoods of the street-lamps need to be carefully looked after.

8. Number all the poles with yellow paint applied with a stencil on a black ground; and keep a record book of the position of each one and its distance by the line from the test-station.

9. In selecting a turbine-wheel, consult competent authorities as to the available fall and minimum quantity of water, and when making the purchase do not expect to get a $1,000 wheel for $100. Pay a fair price and insist, not only that the wheel shall be well made in every way, but that it shall be tested by an expert before acceptance. If it does not give an average efficiency of 76 per cent. between half-gate and full-gate, it is not advisable to accept it, inasmuch as you can easily do better, as our own experience proves.

10. I think our experience shows that it is possible to largely increase the net earnings of an old plant without necessarily renewing it throughout, but plenty of time should be taken for consideration as well as for execution, in order to secure satisfactory results with a moderate expenditure.

Electric Power in Factory and Mills.

In our issue of last week a short abstract was given of a paper with above caption, by Prof. F. B. Crocker, V. M. Bendikt and A. F. Ormsbee, read at the Niagara meeting of the American Institute of Electrical Engineers, and we print below in full the portions relating to power tests of machine tools and the applications of electric power in New England mills.

In the tests which follow, the power required to drive the tools was obtained by placing an ammeter in the circuit of the motors running the various machines and groups of machines, and taking readings every few seconds, the frequency of the readings depending upon the nature of the tool and the work it was doing. The potential was practically constant at 110 volts, not varying more than 1 or 2 per cent. The first tests were made at the factory of the Crocker-Wheeler Electric Company, at Ampère, N. J., and the machines tested and the results obtained were as follows:

Large boring machine.—This machine was driven by a 1½-hp motor, speed 1,200 revolutions per minute, mounted directly on the frame of the tool, the reduction in speed being obtained by the use of gearing. During this test, which lasted three hours, the machine was used for turning down a commutator for a 100-hp dynamo. The average current drawn was 8.3 amperes, representing 1.23 hp at 110 volts. Before the run was finished, the speed of the tool was increased by changing the combination of gears, and during this time the power required was 1.43 hp. When the machine was started from rest, the rush of current was considerable, the average being 17.75 amperes, representing 2.6 hp. It will be seen that this motor is well suited to the machine, the average load being very close to the rated power of the motor.

Drill press.—A drill press was run by a 1-hp motor, speed 545 revolutions, mounted on a shelf at top of press and belted down to countershaft at bottom and thence up again to main shaft of machine, thus securing a reduction of the speed. This machine was boring the faces of the cast-steel pole-pieces of a 10-hp motor, two cutting tools being used. The test lasted 4 hours and 40 minutes, and during this time the pole-pieces for three motors were bored. The first run covered 1 hour and 10 minutes, and the average current was 2.92 amperes, representing .43 hp. It required 15 minutes to replace the completed pole-piece by another one. This second piece required 2 hours and 32 minutes to finish, and the average amperes was 2.82 or .41 hp. This time it required 17 minutes to replace the piece and then the machine ran only 23 minutes until closing time. The current for this short run was 2.81 amperes, representing .41 hp. The total length of time the machine was running was 4 hours and 5 minutes. Therefore power was supplied to the motor 86 per cent. of the time of the test.

Drill press.—This machine was similar to the one preceding, but the work was different; namely, drilling half-inch holes in cast-iron bearings. The average current was 2.86 amperes, which represents .42 hp.

Drill press.—This tool was the same as the other two, and the work consisted in boring the inside of cast-iron bearings. The average in this case was 1.9 amperes or .28 hp. It will be noticed that in the case of these three machines a motor of one-half horse power would be of ample size to do the work.

Punch press.—This was a small punch run by 1-hp motor mounted on the base of the machine and belted to its heavy fly-wheel. The speed of the motor was 700 revolutions. This tool was punching slots in sheet-iron discs for a 10-hp armature, there being 28 slots in each disc. The motor was turned off every time a disc was replaced, but it did not come to a dead stop as the inertia of the fly wheel was so great. Readings were taken every five seconds, and the time of turning on and off the current was noted. The test lasted 57 minutes, during which time the current was turned on for 35 minutes and 45 seconds, or 62.7 per cent. of the time. The average current was 4.86 amperes, equivalent to .71 hp. The rush of current at starting varied from 7 to 15 amperes, depending upon the haste of the workman in turning on the starting box.

Gang Drill.—This tool was driven by a 1-hp motor, 1,000 revolutions, mounted with vertical shaft in frame of the machine and belted directly to the three drill spindles. The material drilled was cast-iron, and the sizes of the holes were one-fourth inch and three-eighths inch. The average of the readings taken was 4.75 amperes, or 7 hp. When the drills were running free the motor took 3.5 amperes. Thus the power required to overcome friction was 74 per cent. of the power used while drilling.

Group of two machines, one lathe and one milling machine.—This group was driven by a 3-hp motor, belted to a short line shaft, from which belts ran to the countershafts above the two machines. The average current was 10.04 amperes, the power being 1.48 hp. In this test special attention was paid as to which machine happened to be running free, cutting, etc., with the results given in the following table:

Class of Machines and Work.	Amperes.	Horse-Power.
Milling Machine running Free—Lathe at rest..	5.67	.836
Lathe Machine running Free—Miller at rest....	7.36	1.085
Both running free.....	10.	1.47
Milling Machine Cutting—Lathe run free.....	10.33	1.52
Lathe Cutting—Milling tool running free.....	14.42	2.12
Both tools cutting.....	15.4	2.28
Cutting rate increased on the lathe.....	17.8	2.61

Group of six machines, consisting of 1 milling machine (small), 2 lathes (10 or 12-inch swing), 1 grindstone, 1 drill press and 1 small punch press.—The last-named tool was not run at all during the test, and the grindstone ran continuously. This group was run by a 1-hp motor, belted to the usual ceiling line shaft. The average current required to drive these machines was 5.86 amperes, representing .86 hp. Thus this motor ran at about its most economical load.

Group of seven machines, 1 planer (small), 1 grindstone, 4 lathes, hand-turning lathe.—A 3-hp motor was used to drive this group, being belted to a line shaft, the same as the previous groups. The current was 13.36 amperes, or 1.97 hp. When the entire group was in use 2.65 hp were required.

Group of 7 lathes and 1 grindstone driven by a 3-hp motor.—The average current was .92 amperes, and the power required was therefore 1.46 hp. The power used by the motor when different numbers of lathes were running is shown by the following table:

Number of Lathes Running.	Amperes.	Horse-Power.
One.....	7.76	1.14
Two.....	9.16	1.35
Three.....	10.69	1.58
Four.....	12.28	1.8

Thus, in a group like this, it only takes 63 per cent. more power to drive four lathes than it does to run one, the reason being the fact that it probably takes about 1 hp to drive the countershafts.

Group of two machines, a large punch press and a large planer.—The motor for running this group was placed on the floor and drove a short line shaft on the ceiling by the usual form of belt. The rated capacity of this motor was 7½ hp, and its speed was 1,350 revolutions. The punch press did not run during the test. With the planer idle and the motor driving the shafting and belting alone, the current was 15.5 amperes, which represent 2.3 hp. While the planer was at work the motor required 33.1 amperes or 4.87 hp. As the loss from friction in the shafting is nearly constant under the variation of load, the power required to overcome this friction was 47 per cent. of the total power used. When the bed of the planer reversed from its slow cutting stroke to the comparatively rapid return stroke, the current increased to 52 amperes, showing an expenditure of 7.6 hp for a few seconds. This tool was planing the frame of a 90-kw multipolar dynamo, the material being cast-iron.

This group was a very large one, consisting of 20 machines; 8 lathes, 4 milling machines, 3 planers and shapers, 2 grindstones, 1 vertical shaft grinding machine, and 3 small tools. The motor in this case was rated at 10 hp at 750 revolutions. A Thomson recording wattmeter was placed in the circuit of this motor for one afternoon. At the end of this time the wattmeter showed a total of 17,854 watt-hours used, and as the time was five hours, the average power was 3,571 watts or 4.78 hp. The average number of machines running was 13, most of the lathes being in use the greater part of the time. An ammeter was inserted in the circuit of the motor for a few minutes, and it was noted that the work was very steady, the current not varying more than three or four amperes at any time.

A group of five machines run by a 3-hp motor was next tested.

Of these five machines, one was a lathe with 17 inches swing and 8 feet bed, one was a slotter, and the other three were lathes of 12 or 14 inches swing. The average amperes were seven, and the power 1.03 hp.

The last tool tested at this factory was a large new engine lathe of 50-inch swing, which had just been set up. This tool was driven by a 3-hp motor mounted on an iron bracket built in the base of the machine. The motion of the motor shaft is transmitted to the tool by gears, thus doing away with all belts. The work done was turning a 5½-inch steel shaft for a 200-kw dynamo, facing the ends, etc., the cut being very light, as the work was only preliminary. The average current consumption was 11.4 amperes. Hence the average power was 1.68 hp.

The following tests were made in the erecting shop of the De La Vergne Refrigerating Machine Company, at Port Morris, N. Y.

Planer.—A large planer, 120 inches between posts, by 108 inches high, by 22 feet bed, was driven by a C. & C. motor of 15 hp. The voltage employed was supposed to be 220, but due to an incorrect station voltmeter the actual potential only averaged 190 volts on the morning of this test. The average current was found to be 20.08 amperes which at 190 volts represents 5.11 hp. At the reversal from the cutting to the back stroke the current increased to 85 amperes, equivalent to 21.65 hp. The power required during the cutting stroke was 4.76 hp, while on the return stroke the average was 5.73 hp.

Drill press.—A drill press driven by a 5 hp C. & C. motor was tested in the afternoon. The potential was raised before this test so that the average was 215 volts. The power required when drilling various size holes is shown in the following table:

Size of Drill.	Amperes.	Horse-Power.
Running Free.	3.	.865
⅞ in.	4.07	1.23
¾ in.	4.37	1 26
⅝ in.	4.6	1.33

Corliss cylinder boring machine.—This tool was driven by a 10-hp C. & C. motor and was boring the brass boxes, 6¾ inches diameter of the main shaft bearing of a large ice machine. The average current was 14.47 amperes, representing 4.17 hp at 215 volts.

The results obtained in these tests show that the power required to drive machine tools has been considerably overestimated, for it will be noted that with a large majority of the tools tested, the motor was not more than one half loaded, and in these cases it was seldom that the load equalled the full power of the motor, even for an instant. In the case of the large planer, although the motor was overloaded 50 per cent. upon reversal of the bed, the average load was only one third of the rated full load. With this machine, however, when the piece of work is very short, necessitating more rapid reversals, the average load will be much nearer the most economical output of the motor.

The question of running machine tools by individual motors or grouping a number of machines together and driving them by one motor, does not seem to allow of a general solution. It would not be advisable, for example, to use the individual system where there are a number of small tools, each one of which requires only a small fraction of a horse-power. On the other hand, if we have a large tool that requires considerable power, it would seem to be far more economical to run it by a single motor, using as little belting and shafting as possible.

Many of the manufacturers of machinery are now supplying boring mills, punching presses, drill presses and other machine tools arranged to be driven by electric motors. In most cases all that is necessary is a shelf or bracket on the tool to support the motor and a gear wheel in place of the main pulley, unless a belt connection is preferable. A press or other tool having a large fly wheel may be driven very conveniently by cutting teeth on the edge of the wheel which gear with a pinion on the motor shaft.

Electric power in the New England cotton mills.—The introduction of the electric system of distribution of power in the cotton industries of New England is now fairly begun. Although there are no large mills driven entirely by this system, a number of them have an electric plant and certain sections of the mills are driven by motors. An electric plant was installed four or five years ago in the works of the Silver Spring Bleaching & Dyeing Company, at Providence, R. I., but it was intended chiefly for lighting. But motors were placed in the carpenter and repair shops, and several other places, until at present there are about 100 hp of motors installed in eight units. The generating plant consists of three 100-hp U. S. dynamos belted together from a countershaft which is driven by a Corliss engine. Two of the machines are 110-volt dynamos which are used for lighting and running most of the motors at present. The third machine, which has just been installed, is a 500-volt Westinghouse power generator of the same type as the lighting machines. There is only one machine at present connected to the 500-volt circuit, a 30-hp motor which drives a centrifugal pump supplying a storage reservoir with water for use in the bleacheries. The electric plant in this mill is not of much importance yet, but its chances for development are very bright since there are a number of machines now run by individual steam engines. These could be most advantageously replaced by electric motors as they are in some cases a great distance from the boilers, involving large losses from condensation.

A very fine electric plant has very recently been installed to drive the calico printing machines at the works of the Donnell Manufacturing Company, at Pawtucket, R. I. The problem for running this class of machinery by electric motors has been a very difficult one to solve, for the motor must be capable of running at a number of different speeds and running constantly at any given speed with a variable load. In this case it has been solved by the use of a modification of the Leonard system of motor regulation. The outfit for each printing machine consists of a motor and a dynamo of the same size, the field rheostat of the dynamo being placed alongside the printing machine. The speed of the motor is thus changed by varying the voltage of the particular dynamo which supplies it with currents.

The dynamo room contains 11 dynamos of the new moderate-speed, four-pole type, made by the General Electric Company. They are run by a Corliss engine through a system of belting and ceiling countershafting. Six of these are 20-kw machines and four are 25-kw. The eleventh dynamo is a similar 20-kw machine used for exciting the fields of the other dynamos. The normal potential is 250 volts, and is lowered in any particular dynamo when slower speed of the motor connected to that circuit is desired. This plant has been completed but a short time, and it was not possible to obtain any accurate figures showing the power used by the motors under various conditions of speed and load. Formerly the machines were run by individual engines, and much difficulty was experienced in starting them, as the pressure of the printing rolls against the cloth is so great. With electric motors this difficulty is overcome, as the motors will stand a very heavy overload for a short time, and the starting torque is very great. The great advantage of the electric system as here used is not so much in the saving of power as in the convenience to the workmen, and hence the increased production.

The saving of power, however, is quite considerable, as in the old system steam was piped several hundred feet to the small individual engines, which were necessarily inefficient under the best conditions, and added to this the engines were run part of the time with partly closed throttle, still further decreasing the efficiency. With the present system the attendant at the machine may quickly vary the speed any amount by turning the rheostat near the machine.

Although this plant has been in operation only a short time, it is claimed by those in control that the production is materially increased. In a paper by Mr. S. B. Paine in *Power*, June, 1895, he states that the increase in the production amounted to more than 25 per cent., and that the quantity of "seconds" (inferior product) was also considerably reduced.

This is very important, as the men in charge of printing machines are skilled workmen of the higher order, and a small saving in wages for a given production is of more value than a considerable saving of power.

At Taftville, where the Ponemah mills are located, there is not sufficient water-power to drive all the machinery, so an electric plant was installed at Baltic, 4½ miles up the river, where a dam had been built, giving an available head of 34 feet. The wheels are horizontal balanced turbines, two of them being rated at 800 hp each, while the third one is rated at 300 hp. The wheels are belted to a long line shaft, which is in turn belted to the dynamos. The generators, of which there are two, are placed in a separate room. They are of the three-phase General Electric type, and are capable of supplying 250 kw at 2,400 volts. They have ten poles and run at 600 revolutions, giving a frequency of 50 cycles per second. The field is excited by a 3-kw bipolar dynamo belted from the generator

shaft. The power is transmitted to Taftville by a very well-constructed pole line. The motors are located in the basement of the Ponemah mill near the engines which they replace. They are belted to pulleys which are connected to their respective shafts by friction clutches in order to enable the motors to be started without load, as they are of the synchronous type. The motors are identical with the dynamos except in having an induction winding of heavy bars sunk in the pole-pieces, to cause them to be self-starting. In starting the motors, the switch in the induction circuit is closed and

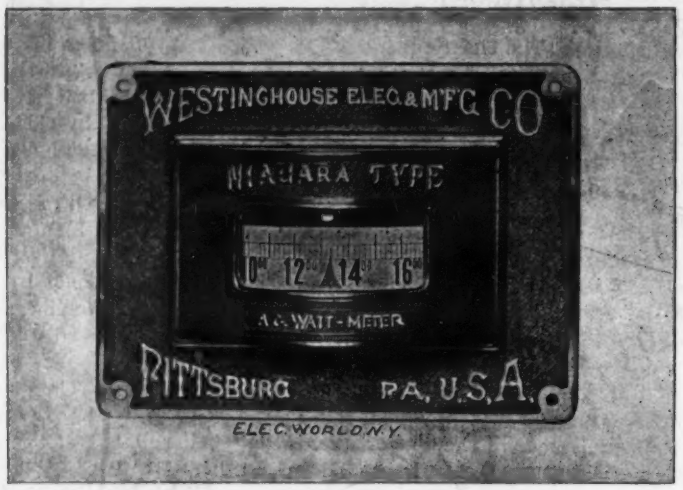


FIG. 1—WATTMETER WITH CASE.

then the line is connected to the armature, causing it to start as an induction motor, without a very great torque, however. When the motor has nearly reached full speed the field is excited, and it will speed up until it falls into step and then the induction switch is opened. This method of starting has two advantages: first, no auxiliary motor is needed; second, no device is required to tell when the motor is in synchronism with the generator.

One of these motors drives 1,200 looms requiring an expenditure of about 155 hp. The other drives 500 looms and also the railway generators for the Norwich Electric Railway Company. The introduction of this plant has enabled the company to concentrate all its power for use in one mill, tending to decrease the cost of production, diminishing transportation charges, and avoiding the use of any coal for steam power.

The Westinghouse Electric & Manufacturing Company's New Plant—IV.

NEW APPARATUS.

Shallenberger Wattmeter.—The new line of Shallenberger alternating-current measuring instruments was described in THE ELECTRICAL WORLD, Jan. 5, 1895, when the patents were first issued. Since that time a number of instruments have been built for the Niagara installation, and some slight modifications and improvements have been introduced which make it worth while to further describe these meters.

The voltmeter and ammeter are but modifications of the integrating wattmeter; the former, instead of having their rotating part free to revolve, are supplied with an opposing spiral spring whose strength is proportional to the angle of deflection. The rotating parts of the integrating wattmeter are a thin aluminum disc supported by an upright spindle resting on a special form of bearing invented by Mr. Shallenberger. The spindle is connected with a light train of gears, constituting the recording device of the meter. Above and below the disc are one or more coils, one set connected

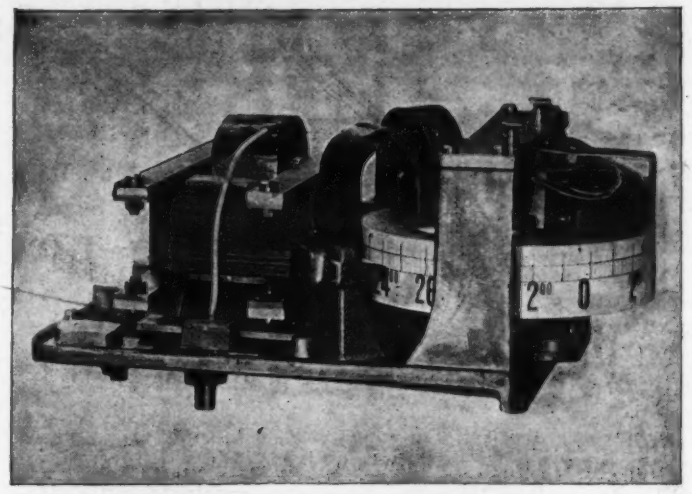


FIG. 2.—SIDE VIEW OF WATTMETER.

in shunt and the other in series with the circuit whose energy is to be measured. Figs. 1, 2, 3 and 4 give different views of this type of instrument.

In wattmeters of ordinary construction it is customary to connect one set of coils in series with the work circuit, and the armature carrying the other set of coils in shunt to the same circuit.

The deflection is then proportional to the power transmitted, and a maximum when the shunt and series currents are in the same phase. In the Shallenberger wattmeter the usual condition as to phase relation between the currents has been reversed, and the torque is zero when the two currents are in the same phase, and at a maximum when they are a quarter of a phase apart. Consequently, if the work current lags behind this position of quadrature, the torque is correspondingly reduced, giving a diminished indication of the meter; and if the lag amounts to a quarter wave length so that there is no work being done in the circuit, the series current is in phase with the shunt current and the rotating parts remain stationary. Since the torque is always proportional to the products of the currents in the shunt and series coils, it is directly proportional to the power transmitted, and, the retarding force being pro-

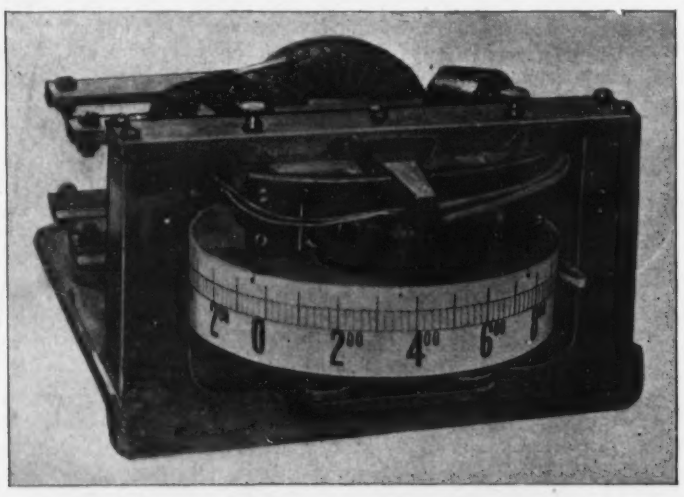


FIG. 3. END VIEW OF WATTMETER.

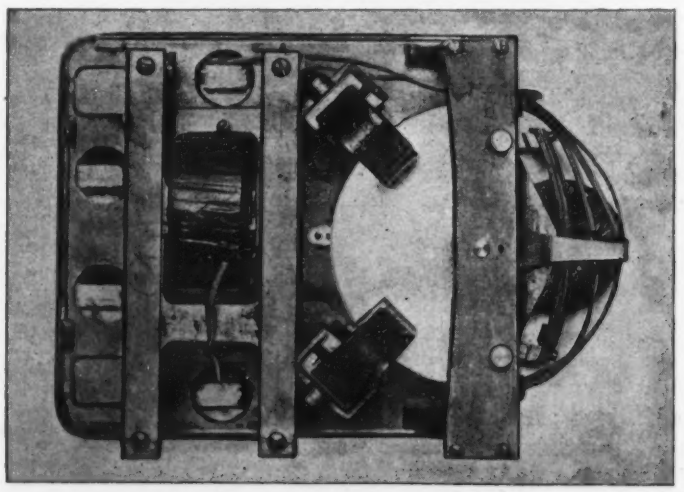


FIG. 4.—PLAN VIEW OF WATTMETER.

portional to the speed, the registration is also directly proportional to the power transmitted.

Permanent magnets embrace the aluminum disc, and are used instead of vanes as a retarding force. When the disc rotates, they produce eddy currents therein, which increase directly as the speed,

and hence the retarding force is directly proportional to the speed, as stated above.

The meters are designed to measure currents of any circuit having aperiodicity of from 25 to 133 per second. The advantages of this instrument are found in the absence of any brushes or moving contacts, its extreme accuracy, the lightness of moving parts and the small friction in comparison with the forces doing work. The meters are designed for use on the secondaries of special transformers, which are so proportioned as to avoid errors from change of phase. The employment of transformers necessitate only low potentials and small currents at the switchboard, with the accompanying increase of efficiency and safety to attendants.

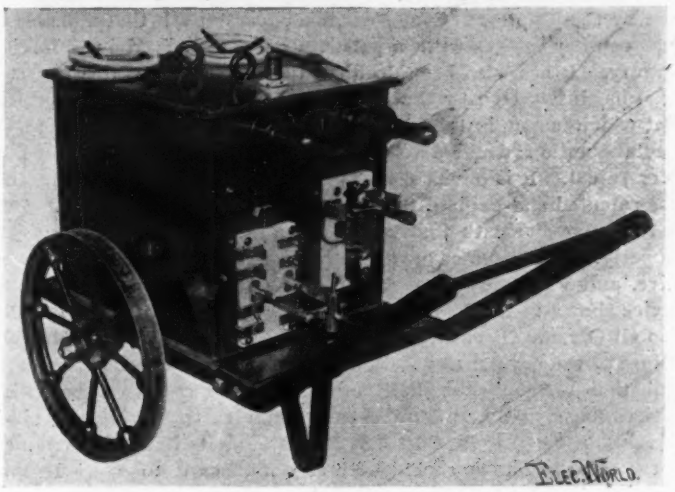


FIG. 5.—TESTING CARRIAGE.

Testing Carriage.—One of the testing carriages in use in the Westinghouse factory is shown in Fig. 5. It is designed to transform the voltage of the ordinary alternating-current lighting circuits up to 500 10,000 volts as required in testing. The two rubber coils on top of the box are the high-potential terminals to be connected to the parts to be tested. The lamp socket is for a lamp which becomes incandescent. The test is being applied by the closing of the double jaw switch, shown in front. When the small circuit breaker on the right is in series with the primary circuit and in case the potential applied breaks down the insulation, the rush of current causes the circuit breaker to act and open the circuit instantly. Within the box are a number of converters with adjustable secondaries for converting the voltage to any required potential.

Electrodynamic Machinery.—XL.

BY EDWIN J. HOUSTON AND A. E. KENNELLY.

276. When an active conductor is bent in the form of a loop, such, for example, as is shown in Fig 193, all the flux produced by the loop will thread or pass through the loop in the same direction, and this direction will depend upon the direction of the current around the loop. If, for example, we consider the loop $a,'\ a,''$

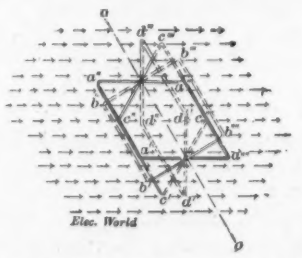


FIG. 192.—LOOP OF ACTIVE CONDUCTOR IN MAGNETIC FLUX.

$a,'''\ a^{iv}$, independently of the magnetic flux into which it was introduced, and send a current of i amperes, in the same direction as before around the loop, the general distribution of the flux around the sides of the loop is represented by the circular arrows, from which it will be seen that all the flux passes downward through the loop as represented by the large arrow. If this loop be now introduced into the external magnetic flux, as shown in Fig. 192, it will tend to rotate, until the external magnetic flux passes through it in the same direction as the flux produced by its own current. Generally, therefore, it may be stated that when an active conducting loop is brought into a magnetic field, the electrodynamic force tends to move the loop until its flux coincides in direction with that of the field.

277. During the rotation of the loop in Fig. 192, from the position a, to the position d, it will embrace a certain amount of flux, say Φ webers, from the external field. In other words, in the position d, the loop holds ϕ webers more flux than in the position a. If the current i amperes, passing through the loop be uniform during the rotation, then it can readily be shown that the amount of work performed by the loop during this motion is,

$$W = \frac{i\Phi}{10} \text{ ergs},$$

but this motion comprises only one quarter of a complete revolution. At the same rate the work done in one revolution would be,

$$\frac{4\,i\,\Phi}{10} \text{ ergs} = \frac{4\,i\,\Phi}{10 \times 10,000,000} \text{ joules}.$$

278. In a bipolar motor with a drum-wound armature on which

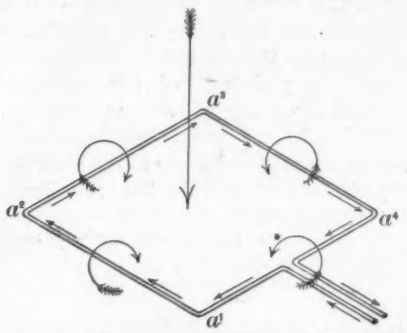


FIG. 193.—DIAGRAM SHOWING COINCIDENCE IN DIRECTION OF FLUX PATHS AROUND A LOOP OF ACTIVE CONDUCTOR.

there are w wires, counted once completely around the periphery, or $\frac{w}{2}$ loops over the surface, there will be $\frac{w}{2}$ times as much work performed in one revolution as though a single loop existed on its surface; the work per revolution will, therefore, be

$$\frac{4\,i\,\Phi}{100,000,000} \cdot \frac{w}{2} \text{ joules}.$$

If now the motor makes n revolutions per second, the work performed will be n times this number of joules in a second, or

$$\frac{4\,i\,\Phi\,n}{100,000,000} \cdot \frac{w}{2} \text{ watts} = \frac{2\,i\,\Phi\,n\,w}{100,000,000} \text{ watts}.$$

Then, as will be shown hereafter, the current supplied at the brushes of the motor will be $I = 2\,i$ amperes, if i be the current through each loop, so that the activity absorbed by the motor will be,

$$\frac{I\,\Phi\,n\,w}{100,000,000} \text{ watts}.$$

We know that the E. M. F. of a rotating armature is

$$\frac{\Phi\,n\,w}{100,000,000} \text{ volts. (See par. 115)},$$

so that we have simply that the activity absorbed by the motor armature available for mechanical work is $e\,I$ watts, and this must be true under all conditions, in every motor.

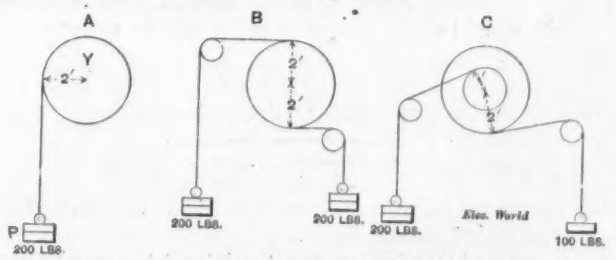


FIG. 194.—DIAGRAM ILLUSTRATING NATURE AND AMOUNT OF TORQUE.

When an E. M. F. of E volts acts in the same direction as a current I amperes, *i. e.*, drives the current, it does the work on the current with an activity of $E\,I$ watts, the activity being expended by the source of E. M. F. On the other hand, when an E. M. F. of E volts acts in the opposite direction to a current of I amperes, and therefore opposes it, or is a C. E. M. F. to the current, the current does work on the C. E. M. F. with an activity of $E\,I$ watts, and this activity appears at the source of C. E. M. F. If the C. E. M. F. be merely apparent in a conductor containing a

resistance R ohms, as a drop $I R$ volts, the activity $E I = I R$. I is expended in the resistance as heat. If the C. E. M. F. be caused by electromagnetic induction, as in a revolving motor armature, the activity $E I$ is expended in mechanical work, including frictions of every kind.

279. We now proceed to determine the values of the rotary effort of a loop at different positions around the axis. This rotary effort is called the *torque*. Torque may be defined as the moment of a force about an axis of rotation. The torque is measured by the product of a force and the radius at which it acts. Thus, if in Fig. 194 a weight of P pounds, suspended from the pulley Y, and, therefore, acting at a radius r feet, the torque exerted by the weight about the axis will be $P r$ pounds-feet. If P be expressed in grammes, and r in centimetres, the torque will be expressed in gramme-centimetres, and if P be in dynes and r in centimetres, the torque will be expressed in dyne-centimetres. Thus, at A, Fig. 194, the torque about the axis of the pulley Y is 400 pounds-feet. At B it is 800 pounds-feet. At C it is 400 pounds-feet.

As an example of the practical application of torque in electric motors, let us suppose that the pulley P is attached to the armature shaft of a motor, and that the motor succeeds in raising the weight W by the cord over the periphery of the pulley, then the motor will exert a torque at the pulley of $W r$ pounds-feet. Thus, if the pulley be 12 inches in diameter = 0.5 foot in radius, and the weight be 100 pounds, then if the thickness of the cord be neglected, the torque exerted by the motor will be $100 \times 0.5 = 50$ pounds-feet, around the shaft, at the pulley.

280. The work done by the torque which produces rotation through an angle θ, expressed in radians, is the product of the torque and the angle. Thus, if the torque τ rotates the system through unit angle about an axis, the torque does an amount of work $= \tau$. If the torque be expressed in pounds-feet, this amount of work will be foot-pounds. If the torque be expressed in gm-cms, the work will be expressed in cm-gms, and finally, if the torque be expressed in dyne-cms the work will be expressed in cm-dynes, or ergs. Since there are 2π radians in one complete revolution, the amount of work done by a torque τ, in one complete revolution will be $2 \pi \tau$ units of work. For example, the motor in the last paragraph which produced a torque of 50 pounds-feet would, in one revolution, do an amount of work represented by $50 \times 2 \pi = 314.16$ foot-pounds. It is evident, in fact, that since the diameter of the pulley is one foot, one complete revolution will lift the weight W through 3.1416 feet, and the work done in raising a 100-pound weight through this distance will be 314.16 foot-pounds. Similarly, if expressed in radians per second ω, be the angular velocity produced by the torque, then the activity of this torque will be $\tau \omega$ units of work per second. For example, a motor making 1,200 revs. per minute, or 20 revs. per second, has an angular velocity of $20 \times 2\pi = 125.7$ radians per second. If the torque of this motor be 10,000 dyne-cms, the activity of this torque, *i. e.*, of the motor, will be $10,000 \times 125.7 = 1,257,000$ ergs per second = 0.1257 watt.

281. A torque must necessarily be independent of the radius at which it is measured. Thus, if a motor shaft is capable of lifting a pound weight at a radius of one foot, *i. e.*, of exerting a torque of one pound-foot, then it will evidently be capable of supporting half a pound at a radius of two feet or one third of a pound at a radius of three feet, etc. In each case the torque will be the same, *i. e.*, one pound-foot.

(To be continued.)

Laboratory of Houston and Kennelly, Philadelphia.

Opinions Regarding the Berliner Opinion.

The following opinions in the recent Berliner telephone decision were crowded out of our last issue:

J. C. Duncan, General Manager People's Telephone Company, Knoxville, Tenn.: "The Berliner decision is of little concern to us as the opinion was not rendered on the United States statute law. Such manipulations have done more to keep down electrical enterprises of all kinds than all of the natural causes combined, and I am sorry to say that some of the electrical journals are largely responsible for a majority of them. I do not know how it is North or East, but the local Bell Company's exchanges in the South are far from what they ought to be in the construction, and also in the maintenance of their lines, and not until we started the present system and got it in order to give a public service here did the old company wake up to the necessity of putting its plant in a serviceable condition. Our system is giving perfect service, and we are putting in new instruments daily and getting our regular rate, while the old company is giving a free service; but we do not care anything for this, as the people are with us."

George Frederick Shaver, the Public Telephone Company, New York: "The expected decision cannot, as far as I can see, affect the situation at all. Telephone manufacturers are not particularly interested to know whether the Bell Telephone Company are guilty of tampering with the Patent Office. They may be able to whitewash the record and get a favorable decision, but public opinion will remain unchanged. The real gist of the whole question is, what does the Berliner patent secure to the Bell Company? Section 4,887 of the revised statutes, as interpreted in the Bates refrigerator case by the Supreme Court, decided once for all that a patent in this country expires with a patent previously issued in a foreign country. It has also been decided that a patent in this country must be interpreted by the state of the art and can only protect that which is new in the art to which it applies. With these fundamental questions decided let us see what effect it has upon the Berliner patent. It is obvious that the Berliner is limited by all that was patented and expired throughout the civilized world from 1877 to 1891, together with that which remained unpatented and public property. The Berliner device as patented is almost wholly inoperative, and when we abstract from its claims the principle and device shown in the Lake patent which expired in England in 1894, also all German, French, and other patents which have expired by failure of the payment of fees and by running their full course, we find that not only the Berliner but many superior transmitting devices have become public property and that nothing remained in the Berliner patent of 1891 at the date of its issue that was new to the art or that any manufacturer would care to use. It may therefore be seen why the Bell Telephone Company inspired the great Fish to such unwonted activity in the Bates refrigerator case, as if the doctrine of allowing the date of application to govern had obtained, the Bell Company's great scheme of keeping the 1877 application along until 1891 would have been a success, from their standpoint, and the state of the art would have been considered only prior to the date of application in 1877. The question of the possibility of infringement of the Berliner patent by the various pulverized carbon transmitters, although a minor consideration, in view of the foregoing, has been discussed very thoroughly by the opposition, and generally held that the claim for 'Electrodes in constant and variable contact' is not infringed by electrodes which never come in contact, but are separated by substances whose electrical conductivity is varied by a change of pressure or a rearrangement of the particles composing the substance. I consider that the argument that all the particles in the path of the electrical current lying between the traditional electrodes, are themselves electrodes, is fallacious, as otherwise the molecules of matter composing the connecting wire and battery circuit are equally good honest electrodes, and all working to uphold the most ingenious monopoly of modern times."

Definition of Polyphased Systems.

To the Editor of The Electrical World:

Sir:—I am much pained to find that my recent letter on "The Definition of Polyphased systems," written with no personal animus toward Mr. Steinmetz—for whom, on the contrary, I profess the greatest esteem—has been given by him an interpretation as far removed from my thoughts as from my character. If I have let it be understood that Mr. Steinmetz possibly had been led too far in *the paradox* by a desire to better distinguish his new invention from systems known under the general name of polyphased systems, I have wrongly supposed that there was reason to think he had submitted to the well-known sentiment of *l'amour propre d'auteur*, and which implies nothing that is not honorable and natural. I did not wish to say anything else in my letter, and I regret exceedingly that Mr. Steinmetz could see in it any allusions to other considerations equally unworthy of him and myself. While my observations, I fear, may have appeared to him somewhat too strong in form, they were not intended as an attack upon his scientific character, which I admire sincerely, nor upon his personal character, to which I would be the first to render homage. I trust that this unfortunate misunderstanding will be promptly dissipated and forgotten.

Paris, France. A. Blondel.

DIGEST OF CURRENT TECHNICAL ELECTRICAL LITERATURE

BY CARL HERING

COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

Note.—Beginning with the issue of July 6, the following changes in the plan of this department were introduced: greater space than formerly will be devoted to abstracts of the more important articles; the large number of references to articles of less importance, especially to those in inaccessible foreign journals, will be reduced; articles belonging more particularly to the science of pure physics, chemistry, mechanical engineering, medicine, etc., rather than to that of electricity, will no longer be noticed.

Note.—Typewritten copies of any of the articles referred to in the Digest, will be furnished at the rate of 5 cents per 100 words for English matter, and 8 cents per 100 words for matter in foreign languages; translations at the rate of 40 cents per 100 words. Copies of any of the journals may be ordered; address Branch Office, ELECTRICAL WORLD, No. 927 Chestnut Street, Philadelphia, Pa

DYNAMOS, MOTORS AND TRANSFORMERS.

Armature Design.—The Lond. "Elec.," June 14, contains a communication by Mr. Parshall referring to the recent criticism in that journal (see Digest, June 22), of the paper of Prof. Ryan on improvements in armature ventilation. Regarding the time required by an armature to attain its maximum temperature, he believes that in machines of the same type, the time increases with the volume of metal but not by any ascertainable law, as far as he can be able to find; small armatures attain their maximum temperatures in three or four hours, large ones in eight to 12 hours and longer; the standard American practice is to allow an increase of about 30 degrees C. With regard to the standard speed he thinks that for direct-connected machines 2,500 feet per minute is an average value and for belt-driven machines 3,200 feet; the peripheral speed in continuous-current machines seems to be a function of the angular velocity, and in alternators, of the frequency: a really satisfactory basis for estimating the cooling surface and to allow for different speeds, is still to seek; the best approximation which he has been able to make is that for a peripheral speed of 3,000 feet per minute the increase of temperature per watt per sq. in. is from 30 to 40 degrees C. and for 2,000 feet, 36 and 48 degrees C.; with the modern ventilated type the increase of temperature calculated in the same way is about one half. In a series of experiments with ventilated armatures he found that the ventilation increased approximately with the square root of the surface speed; with non-ventilated types he has not been able to determine any law. Regarding eddy currents he states that the importance varies according to the size and the construction; the present proportions of armatures are determined chiefly with reference to the sparking limit; the maximum current output per pole is a limited quantity; dynamos with half the number of poles and with longer armatures of smaller diameter could be made to be sufficiently cool but will be less satisfactory as to sparking; great current output with small trouble from sparking can be secured only by a great number of poles. He believes that commutating lugs and face windings are not necessary to balance a dynamo even with ventilating flues, so that the sparking and heating limit occur at the same output and he instances an 800-kw generator which he designed and which was tested at the World's Fair, in which every precaution had been taken to effectively ventilate the armature and commutator, yet the sparking was not noticeable for outputs considerably beyond the limit determined from the safe heating; his experience with commutating lugs has been unsatisfactory; in estimating the worth of such contrivances both the material and labor must be considered and unless there is a saving the complication is increased without a commercial advantage.

Theory of Three-phase Generators.—An article is begun by Mr. Whitwell in the Lond. "Elec. Rev.," June 21, in which he proposes to investigate the action of three-phase generators in a simple manner and with the aid of elementary mathematics only; the present portion, which consists almost entirely of algebraical formulæ, deals with the closed-circuit armature type.

Theory of Synchronous Motors.—In "L'Eclairage Elec.," June 8, Mr. Guilbert gives a brief summary of the theory of Prof. Blondell (see Digest, June 1).

Polyphase Motor Calculation.—A translation of Mr. Cahen's article mentioned in the Digest, Feb. 16, is published in the Lond. "Elec.," June 21.

Commercial Efficiency in Transforming Alternating into Direct Currents.—A translation into French of the article by Mr. Arno, published in the Digest, May 4, is given with the table in "L'Ind. Elec.," June 10.

LIGHTS AND LIGHTING.

Temperature of the Crater of an Arc.—In a short Royal Society paper by Mr. Wilson, reprinted in the Lond. "Elec.," June 21, he considers "The Effect of Pressure of the Surrounding Gas on the Temperature of the Crater of an Electric Arc Light." It has often been assumed that the temperature of the crater is that of the boiling point of carbon, namely, 3,300 to 3,500 degrees C.; the photosphere of the sun is thought to consist of clouds formed of solid carbon and as their temperature is certainly not below 8,000 it is difficult to reconcile the two facts. In order to investigate whether increased pressure of surrounding gas would raise the temperature of the crater he formed an arc in a strong cast-iron box, which was hermetically sealed and in which any desired pressure could be produced; the arc could be regulated from the outside and its image was projected on a screen by means of a lens; a Boys' radiomicrometer was arranged so that the image of the crater fell on its aperture, the instrument thus giving deflections proportional to the radiation from the crater; the current could be varied from 40 to 10 amperes; nitrogen gas was used. It was found that as the pressure rises the resistance of the arc increases and the external resistance had to be adjusted so as to keep the current constant (from this it appears that the current was kept constant throughout all of the tests); at five atmospheres the temperature of the crater had fallen as also the brilliancy of the image; at 20 atmospheres the crater fell to a dull red color; for a moderately good vacuum the radiation was much greater than that at atmospheric pressure; the temperature of the crater was very sensitive to any sudden diminution of pressure; there was no smoke formed inside of the box and the image of the arc was quite clear. From these experiments it seems that the temperature of the crater, like that of a filament in an incandescent lamp, depends on how much it is cooled by the atmosphere and not on the temperature at which the vapor of carbon has the same pressure as the surrounding atmosphere; that carbon volatilizes in some forms at comparatively low temperature seems likely, as noticed in incandescent lamps; the pressure of the carbon vapor in the arc may consequently be very small and the supposition of the high pressure of the solar photosphere is not borne out by these experiments. (It is not stated whether there was any change in the total number of watts in the lamp as the pressure increased.)

Incandescent Lamp.—The manufacture of the Robertson lamp in England is illustrated and described in the Lond. "Elec. Eng.," June 21; a brief description is also given in the Lond. "Elec. Rev."; very little is said regarding the process but it appears that the usual method of carbonizing by surrounding the filament with carbon powder is not employed; the filament is made by the ejection from an orifice, of a carbon-containing fluid which is precipitated chemically at the period of ejection; in the furnace it assumes the character of a bright and hard carbon of great elasticity and capable of scratching glass; the works turn out over 2,000 to 4,000 lamps a day; they make a two-watt lamp, and are prepared to make a 200-volt lamp.

Electric Lighting in Berlin.—Some statistics up to the end of the year 1894 are published in the "Elek. Zeit.," June 13; they are not considered quite accurate; for street lighting there were 185 arc lamps of which 71 ran the whole night; for private lighting there were 9,932 arc lamps, 200,474 incandescent lamps and 667 motors.

POWER AND HEAT.

Welding.—The discussion of Mr. Foster's recent paper (see Digest, March 9 and 16), by Mr. Mountain is published in the Lond. "Elec.," June 21. He finds that it is impossible to do good work with the Bernardos process with a current of less than 300 amperes and for general work in a steel foundry he considers 500 amperes to be the very least; if such currents were used instead of 100 or 150 amperes as in some steel works in Sheffield, the frequent defects would no longer occur; with the small currents the arc is only sufficient to heat locally the spot where the current is applied, but with the large current the heat is spread around, resulting in a much better weld or melt. He gives a table determined experimentally showing the current, voltage, time and length of heated pieces, in welding steel boilers for domestic purposes; with a thickness of ⅜ inches the welds were made at the rate of one inch in 51 seconds; the current required was not less than 300 to 350 amperes. He makes a distinction between welding and melting; for the latter 75 volts at the dynamo is sufficient but for welding 115 to 120 volts are necessary as also a very long arc which can be used as a blow-pipe and which can be moved rapidly over the surfaces; he feels sure that very excellent work can be done if the current per arc is not less than 350 to 400 amperes.

Ice Machine.—A small ammonia machine driven by an electric motor is illustrated and described in the "Elek. Zeit.," June 13; from the data given regarding its output it appears that it will produce 55 pounds of ice per hour with a consumption of 3.66 kw; great advantages are claimed for driving it with an electric motor, the chief ones being convenience and the absence of all heat.

Electric Transmission in Workshops.—In "L'Eclairage Elec.," June 8, Mr. Brunswick discusses this subject and gives the results of some experimental data recently obtained in several European workshops.

Niagara Power Plant.—The "Elec. Eng.," July 3, contains a communication from Prof. Rowland in which he replies to some statements recently published in Lond. "Lightning," by Prof. Forbes, which he considers are far from true. Prof. Rowland's first report to the company was made in 1889 and not 1890; he did not report against the alternating-current system but merely stated that it was not in a commercial state at that time. In giving his opinion in 1892 of the plans proposed by Prof. Forbes, he expressed disagreement with them. He quotes portions of the Forbes specification which includes the following recommendations: to use two-phase alternating currents, light revolving parts not exceeding 10 tons in weight, that the armature contains no iron but only bare revolving copper bars, and that 10,000 volts are generated directly by the dynamo with a period of eight and one third per second. With the exception of the first recommendation he (Rowland) condemns the whole scheme, claiming that a dynamo built after that drawing would not last a month if it did a week; the tremendous racking stress on the coils at that low frequency and at that high potential would be very great, and the light revolving parts would cause an unsteady motion; he therefore recommended a larger dynamo and a weight of not less than 25 tons; the present system does not contain a single feature which he condemned and the whole of what Prof. Forbes intended as his final report was swept away, the only feature remaining was the use of the two-phase system; he claims that the system recommended by him (Rowland) is practically that in use to-day, although the exact figures have been somewhat altered; the revolving parts were made 40 tons and the period 25 instead of 42 or 33 and the revolving armature was made the revolving field; "as to whether the changes are for the better, only time can show." He seems to question whether 40 tons can be revolved successfully at 250 revolutions per second.

TRACTION.

Sectional Surface Contact System.—In "L'Eclairage Elec.," June 8, Mr. Jacquin begins a detailed description of the Claret and Vuillenmier system which was used in Lyons, and which has already been described in these columns (see Digest, Oct. 13, 20 and 27; also May 18 and June 1). He calls attention to the great importance of preventing accidents due to a possible failure of the apparatus which disconnects the section from the mains, and he describes two ways in which a disconnection of the section, after the car passed, may be assured. The first and the best is to have an additional sliding contact at the rear of the car, the distance of which, from the other contacts, is greater than the length of one section; this contact is connected directly to the body of the car and therefore to the return circuit through the rails; if for any reason the section remains connected to the circuit, this contact will connect it with the ground, thus blowing the fuse in its circuit. The second device contains a shunt-wound electromagnet, is much more complicated, less sure and more specifically adapted to that particular system.

Railway Return Currents.—In referring to some recent American papers on this subject the Lond. "Elec. Rev.," June 21, suggests that "an insulated bare return conductor laid along the track and connected by a brush on the car, would be the ideal system" (presumably it is meant that the conductor is bare only where the brush on the car touches it; such a system, however, would be fatal to horses as, we believe, a horse can be killed with 25 volts). The object to be aimed at, being to reduce the track as nearly as possible to zero potential throughout, it suggests that this might be effected theoretically by connecting each short section of the track to the negative pole of a generator at the necessary number of volts below zero potential by insulated conductors of such resistance as will just draw off the quantity discharged into the section; but as the supply is irregular, the constant zero potential method is practically impossible; it is believed, however, that a great improvement will be effected by having a reasonable number of insulated conductors connected at regular intervals along the track.

Berlin and Milan.—According to the Lond. "Elec Eng.," June 21, it is distinctly announced that the Berlin municipal authorities have concluded an agreement with Siemens & Halske for the construction of an electric overhead railway in that city and the Milan authorities have granted a concession for the conversion of the horse lines into electric lines.

Will Trunk Lines Be Operated by Electricity?—The "Eng Mag." for July contains a short article by Mr. Sprague; his conclusions are similar in many respects to those in Dr. Duncan's recent address (see Electrical World, July 6, page 11). He refers to the statements of the over-enthusiastic prophet and says that it may be safely stated that there will be no material advances except such as accomplish manifest economies and show a commensurate return; the answer to the question is similar to that referring to the replacement of the telegraph by the telephone or gas by electric light, namely, that it is not exclusive and that its reign will not be universal. He points out advantages of the present trolley lines, stating that they will act as feeders to the great trunk lines both for passengers and a certain class of freight and they will largely encroach upon special fields now occupied by the trunk lines; but when one departs from this class of service and takes up what is essentially a trunk line system there are many questions to be considered, the most important being trunk line freight service; unless passengers and freight can be carried with increased benefit to the community and at a reduced cost or with a commensurate return on capital invested an electric will not replace a steam system; there is a distinct limitation to the distance and amount of power which can be conveniently and economically transmitted and distributed; he does not include among trunk line systems one in which a number of stations are distributed along a long line; smaller units run at more frequent intervals are of less importance in dealing with long distances; when trains are operated in large units with comparatively few units between terminal points and at considerable intervals the steam locomotive will absolutely hold its own; but when smaller units are dispatched at frequent intervals and distributed in large numbers along the line, then and only then will electricity be used on suburban lines and lines joining important cities, whether the speed be high or low; from the standpoint of passenger traffic it is entirely feasible to operate roads between such points as New York and Philadelphia on a sub-divided electric system, but this is not all that is required. The more frequent the units the more exclusive must be that particular track for that particular service and the larger must be the number of tracks; he points out the advantages and disadvantages of a six-track line. The 30 to 50-car freight train pulled with a single locomotive presents an economical transportation which no system of units on long-distance transportation can hope to equal. To reach the highest standard every car should be made an individual unit; to use units of 1,000 to 1,500 hp, as is common on steam roads, would entail an enormous loss of energy and the variation of pressure on the line would make the cost, with any possible allowable loss, entirely impracticable; electric railways develop a field of their own with recognized limitations and vast possibilities; they will fill that field to the practical exclusion of all other methods; they will replace the locomotive system on many suburban and branch lines and will prove a valuable auxiliary to the trunk systems, but the electric system has not sounded the death-knell of the locomotive any more than the dynamo has sounded that of the stationary steam engine.

Chicago.—The "West. Elec.," July 6, publishes a long and well-illustrated description of the electrical systems of the North and West Chicago Street Railway Companies.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

Electricity Supply from Town Gas.—A paper by Mr. Medhurst is reprinted in the Lond. "Elec. Eng.," June 21. He points out the well-known effects of the varying load factors in steam-driven stations and shows that if operated by gas the difficulties would be overcome and he believes it to be the only way in which electric supply works can be carried on so as to benefit gas undertakings. He endeavors to demonstrate this by a case in which the municipality owns the gas works; he takes the case of an 180-kw alternating high-tension system with transformer sub-stations; the cost of the installation would be about $3,000 more if run by steam than if run by gas; the three alternators would not be run in parallel as that is not good practice when gas engines are used, nor is it essential, as is shown in the New Castle station which is one of the most successful in England, and in which they have never been run in parallel. He estimates a saving of about $2,000 in the buildings and foundations; from a table giving the results of a number of large stations, the average of which is about 110,000 kw-hours, the average cost of production and distribution is 5.52 cts.; a 100-hp gas engine consumes about 20 cu. ft. per hp-hour at full load but as they are not run at that load he assumes 80 cu. ft.; the cost of producing 1,000 feet of gas he estimates as 29 cts. including interest; the cost of gas per unit sold to consumers is therefore 2.24 cts., while the average cost of coal in the steam stations referred to was 2.26 cts.; the net results would be that the costs of production are about the same in both but the advantages on account of decreased capital are decidedly in favor of the gas plant.

Test of a Private Gas Engine Plant.—The results of some tests of a plant at Olympia are published in detail in the Lond. "Elec. Eng.," June 14; some of the figures were given in the Digest last week; the plant consists of a 38-hp gas engine and a 16-kw dynamo; among some further results are the following: the combined efficiency, that is the electrical hp divided by the electrical hp at full load, was 69 per cent.; the cost of gas per hour while running without a load was 10 68 cts.; the cost of gas per hour per unit generated was 2.2 cts. for one third load, 2.12 cts. for two thirds load, and 1.65 cts. for full load; the watts per indicated hp at full load were 514.84 and per brake hp 638.4; gas was taken as costing 41 cts. per thousand. If the engine had been

more nearly proportional to the work to be done by the dynamo the efficiency would have been improved.

Test of a Combined Light and Railway Station.—The tests described in a paper by Messrs. Jackson and Richter, read before the Detroit meeting of the American Society of Mechanical Engineers, refer almost exclusively to the engines and boilers, the data being given in the form of a table and sets of curves; the plant contained an engine of 380 hp for arc lighting, one of 190 for railway generators and one of 400 for an alternator; the results of the tests are said to be nearly equal to those obtained by the average electrical station in smaller sized cities; six station employees were required for the 24-hour run. The conclusions are drawn with reference to the question of whether combined stations can be operated at a much less total expense than two smaller stations in which the lighting and railway plants are separate; in regard to station labor they conclude that it would be proportionally larger for two stations than for one; the fuel economy is probably no better than would be given by similar engines and other machinery in separate plants; the question of superintendence must be considered from two sides, first, when the railway and light companies are independent, the latter selling power to the former, and second, when one company controls both; in the first case no saving is made in office force or superintendence by combining the stations, but in the second case, there is doubtless a saving; under the fixed charges the real estate and buildings are undoubtedly increased to some extent in separate plants but not so largely as might be imagined, since the running machinery for the two classes of service must be entirely independent, as it is practically impossible for an engine to drive a railway generator and regulate with sufficient accuracy for lighting; on account of the separation of the two classes of machinery, the space and buildings for the combined plant must be larger than for either a small lighting plant or a small railway plant of a capacity equal to the combined plant. There is no light thrown on the question by the comparison of the load factors of the separate and combined plants; in the present station the 24-hour engine load factor for the railway and the alternator was 38.2 per cent., for the arc light machinery 25.6 per cent., and for the other alternator 14.56 per cent., the total for the stations being 32.4 per cent.; by separating the lighting and railway outputs the railway load factor remains the same and the lighting load factor becomes about 23 per cent; practically the same amount of boiler power is required in the combined stations as in the separate stations and exactly the same engines and dynamos. The gains by combining are therefore a fair amount in the labor account and a small amount in the real estate and buildings; the gains are not nearly as great as are sometimes assumed nor are they comparable in magnitude with those which result from the combination of two like stations into one.

Location of Electric Light Plants.—An article by Prof. Crocker is published in "Elec. Power" for June; he discusses the subject from a practical standpoint under nine different headings, representing the considerations which are involved; it does not admit of being abstracted. In conclusion in referring briefly to the location of generating stations at coal mines, which is the extreme case of the location of a station entirely with reference to coal supply, he states that while advanced civilization will probably demand it in the future it is doubtful if the times are quite ripe for attempting it at present except in cases where the conditions are particularly favorable; a compromise scheme might be adopted in which the station would be located at a sufficient distance from a city to avoid smoke and dirt and reduce the handling of coal.

WIRES, WIRING AND CONDUITS.

Okonite.—The Lond. "Elec. Rev.," June 21, contains a reply by Dr. Fleming to an article, abstracted in the Digest last week, in which his recent report was criticised very unfavorably by that journal. He claims that the criticism conveys an erroneous impression of the kind of examination which he made, and that the description given was an imperfect one. Regarding the statement that the high-pressure tests lasted only three minutes he states that all the tests were cumulative, the same sample being tested with increasing voltages with five days' immersion between the tests, and he therefore claims that the effective duration was the sum of all the times, amounting in all to about a quarter of an hour, under the maximum pressures; regarding the action of the various chemicals, he states that the samples were soaked 34 days and then tested with 3,360 volts; he calls attention to the fact that no particulars were given by the journal concerning the cable with which a comparison was made; he disagrees with the statement that the heat test would give the required information regarding durability; most people prefer to know the effect of a long soaking in water; regarding the statement that the experiments would have given wrong conclusions if applied to gutta-percha, he states that they also would have led to an erroneous conclusion if applied to paper insulation or any other different material.

In an editorial reply to this letter, the editors endeavor to confirm their former conclusion; it is claimed that the allusion to the tests being cumulative is nonsensical, as five minutes per day for instance, for 30 days could not be considered as an equivalent to a continuous test of 2½ hours; a cable may stand high pressure for a few minutes and yet break down under a similar and continuous strain. The same journal published some comparative tests made some time ago by Mr. Swinburn with okonite and with Henley's vulcanized india rubber leads having nearly the same thickness of dielectric; for a thickness of insulation of about 0.08 inches the insulation resistance in megohms for the okonite was 2,000 and for Henley's 5,000, while the breaking-down voltages were about 14,000 and 24,000 respectively.

Concentric Leads.—A recent paper by Mr. Grosselin is abstracted briefly in "L'Ind. Elec.," June 10, and "L'Eclairage Elec.," June 8. In England the outside conductor is always grounded, while on the continent both are insulated; in the Champs-Elysées plant he found that 3,000 volts existed between the two wires as also between each wire and the earth; he concludes that the insulation for the exterior wire is useless; in experiments made by Mr. Neustadt on 2,000-volt circuits he always found that the external insulation was pierced when "short-circuit boxes were opened or closed"; there was never any accident if the central conductor was not connected to the dynamo. He comes to the conclusion that an insulation of the exterior conductor equal to two thirds of that of the central conductor, is useless and insufficient, it should either be the same for both or the thickness should be reduced to a minimum and lightning arresters added; that it is necessary to find a means to diminish the action of self-induction; that the central conductors should never be connected to the machine alone; and that it would be safer to connect the external circuit to earth at one point and not along its whole length.

Effects of Temperature on Cotton and Silk Insulation.—In an article by Mr. Reeve in "Elec. Power" for June he gives the results of tests at increasing temperatures in order to find at what temperature the safety limit can be placed and to study the action above and below this limit. A brass test spool, exposing nearly 10 sq. in. of area of core, was wound with two separate layers of No. 20 B. & S. wire and the insulation was measured between these two disconnected wires; these spools were placed in a closed vessel, which was heated electrically at atmospheric pressure. The results may be divided into those which take place below 125 degrees C., those between that and 180 and those above 180; when temperature was first raised gradually, the insulation dropped very rapidly to a remarkably low value up to 100 degrees while above that temperature it again becomes better; when reduced to 25 degrees again the resistance was higher than at first; he attributes this action to the moisture and proves it by showing a marked effect of dry, hot, air force around the coil; by getting rid of the moisture the resistance could be raised 50 per cent.; he believes that materials become more absorbant as the temperature rises; the rate at which the temperature rose seemed to affect the lowering of the resistance, as the more rapid the rise in temperature the greater the reduction in the insulating property; the results are given in a table in which the resistance in megohms per sq. in. is given for a number of different temperatures and wires and which shows among other things that cotton is much more absorbant of moisture than silk; at 125 degrees C. the moisture phenomenon is practically insignificant, an increase of temperature still produces a lowering of the resistance and there seems to be a definite value of the insulation for each degree; up to 180 degrees neither cotton nor silk suffer any injury whatever even during several hours' time and the value is very constant and critical; less than one hour's run at 190 degrees produces a light brown scorching; 250 degrees reduces both rapidly to a black charcoal although the insulation resistance is by no means reduced to zero thereby. On four of the wires tested the resistance reaches a minimum very close to the boiling point of water; it appears that the thickness of the insulation does not by any means determine its resistance, single and double not varying very much in actual value except from a mechanical standpoint; it is not correct to attribute the insulation to the air space alone as the resistance of this space depends entirely on the moisture it contains and hence, apart from mechanical strength, it is the nature of the substance with respect to moisture that determines its value as an insulator; in two specimens the resistance at the boiling point of water fell to about one fortieth of its original value and in another case to one three-thousandth; all of these were wound with cotton while with silk the reduction was only about one tenth, the original figures being also much higher than that of cotton; although silk seems to be better as an insulator in the beginning he believes that in the long run cotton is superior. In his conclusions he states that most machines are run at a temperature at which their insulation is the lowest, unless carefully protected from the absorption of moisture, that baking at a temperature of 150 degrees C. and then protecting the insulation from the absorption of moisture, will greatly improve it but the material should not be shellaced first and baked afterward as is frequently done; that cotton and silk are not injured up to 180 degrees C. (356 degrees F.); and that copper will oxidize quite badly, considerably below 180 degrees C., hence the wire itself is injured somewhat before its insulation.

ELECTRO-PHYSICS AND MAGNETISM.

Invention of the Electromagnet.—Mr. Pellissier, in "L'Eclairage Elec.," June 8, claims that it was not Sturgeon who invented the electromagnet, as is claimed in Thompson's book on *The Electromagnet*

and shows from records which he quotes that Arago was really the one to discover it in 1820, the date of Sturgeon's discovery being given by Thompson as 1825.

Relation of Hysteresis to Temperature.—A paper by Messrs. Laws and Warren read Oct. 10, 1894, is reprinted in the "Proceedings of the American Academy," p. 490 (no date given); it is reprinted in "El'ty," June 26. It gives an account of some experiments to determine the effects of temperatures above the normal on the dissipation of energy by hysteresis; the loss was determined by a wattmeter which reduced the time required for the observance, to a minimum; the instrument is described and illustrated; they call it a watt-balance and it measures the ratio of the mean values of two definite integrals, it can therefore be used to measure the efficiency of a transformer, giving the results by a single reading; it consists of two electrodynamometer wattmeters, one over the other, the movable coils being rigidly connected; the connections for the test are given; the watt-balance as used in a wattmeter with an electrodynamic control, the advantages derived from this control, by shunting a portion of the main current, is that any manipulation of the circuits does not disturb the equilibrium of the instrument and that it renders it possible to use the instrument in a zero instead of a compensation method. Means were provided by which the maximum magnetization, of which the hysteresis loss is a function, might be kept constant and measured; the specimens were heated in a fire brick furnace; the material used was the so-called French steel and the sheets were 0.004 in. thick, a number of rings being stamped out and wound with a coil. The method of measurement is described and the results are given in curves and tables, which show that any moderate elevation of temperature up to 270 degrees (presumably Centigrade) has but a small influence on the loss, but at this point a change takes place, the diminution of hysteresis with rise of temperature being much more rapid, such that at 675 degrees the loss is but 13 per cent. of its value at ordinary temperatures; after heating above the inflection point the instrument shows on cooling a marked decrease of the loss, from its value at the same temperature on the ascending curve; if the specimen is heated again a change of direction of the curve takes place, but at a lower temperature; in another specimen the loss measured 0.289 watts at ordinary temperatures while at about —80 degrees it was 0.288, showing that there is practically no change at this low temperature. Experiments were made for finding whether the temperature at which iron becomes markedly magnetic on cooling is the same as that at which the sudden diminution of the magnetic properties occurs on heating and it was found that the two points do not coincide, that on the descending curve being about 12 degrees lower than the other; a difference of form of the curves is noticeable showing that the regaining of magnetic properties on cooling is more gradual than their loss on heating; the sudden exaltation of magnetic properties occurs at the same temperature in the first and second cooling. The results of further experiments are promised in the near future.

Elements of Alternate Current Principles.—"Elec. Power" for June contains a short article by Mr. Hanchett in which he gives a discussion of the subject with the use of as little mathematics as possible.

ELECTRO-CHEMISTRY AND BATTERIES.

Formation of Cuprous Oxide.—"L'Eclairage Elec.," June 8, abstracts an article by Mr. Majorana from the Italian. He gives the results of experiments with two voltameters in series one containing sulphate of copper and sulphuric acid with platinum wire electrodes and the other containing a saturated solution of the pure salt with platinum foil electrode; in the second, cuprous oxide was at first obtained until a certain quantity of the acid is liberated. The practical conclusion from his experiments is that one can obtain pure copper from the electrolysis of the sulphate even with very weak currents, by adding a small quantity of sulphuric acid to the solution.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Absolute Measurement of Electrical Resistance.—A Royal Institution lecture by Prof. Jones is reprinted in full with illustrations of the apparatus in the Lond. "Elec. Eng." and "Elec.," June 14 and 21. He believes the time is now ripe for the adoption of a really absolute unit as the ultimate legal standard; he shows what is really meant by the term absolute, stating that the modern system does not fulfill all the requirements as the fundamental units are not the same at all times and in all places and not unconditioned by the properties of any specified body; he considers the units of length, mass and time to be arbitrary standards; he believes the time will come when the unit of mass will be a derived unit with reference to length and time, the latter being based on some more permanent phenomena of the universe than the length of a particular bar and the motion of the earth; the properties of the sodium molecule, for instance, have been suggested; a derived unit of mass would rationalize the dimensions of the electric and magnetic units in length and time and relegate their irrationality to the ether to which he believes they properly belong; in the present lecture he limits himself to the absolute measurement with reference to length, time and mass and to the properties of the ether. He explains how electrical resistance can be measured in terms of length and time, as it is proportional to a certain velocity, and if the magnetic permeability of the ether can be taken as a unit, the number expressing a resistance will be the same as that expressing a certain velocity; he does not say that resistance is a velocity, as that would be to neglect the unknown dimensions of the magnetic permeability of the ether. He then proceeds to describe in detail the well-known method of Lorenz and Lord Rayleigh which he considers to be the simplest and most accurate of all the methods; in this, a coil of wire is placed in series with the resistance to be measured and a battery; a disc rotates in the opening in this coil, generating an E. M. F. which is applied to the terminals of a resistance, the speed of the disc being varied until no current flows in the latter circuit, as indicated by a galvanometer; the speed in revolutions per second is then multiplied by the co-efficient of mutual induction of the coil and disc, which is calculated once for all from their measured dimensions, and the product is then the resistance. To eliminate thermo-electric forces, which are always present, the two E. M. Fs. which are being compared are reversed, and if the reading of the galvanometer is the same, then the E. M. Fs. are equal. He discusses other practical difficulties that arise; the speed should be as uniform as possible and capable of exact determination; he couples an electric motor to the disc regulating its speed by means of resistances, one of which is a slide wire resistance for the finer adjustment; a shunt is also used for producing sudden changes; with this arrangement the speed can be varied between 150 and 1,500 revolutions per minute; the speed should remain constant for four or five minutes, which is very important. To control the uniformity a stroboscopic method is used, which is described in detail and in which a row of teeth will appear stationary if the speed is uniform and will move if it is not. The vibration of a tuning fork, for measuring the speed, is not sufficiently constant and he therefore measures the rate of rotation by recording the revolutions with the aid of an electrochemical apparatus, together with the record from a standard clock. He gives the results of measurements of a bowed fork, which he considers preferable to the other, showing that the extreme variation from the mean is about one in 65,000. There was difficulty in obtaining a steady reading of the galvanometer, which he overcame by having a constant flow of mercury through a channel in the single wire brush which made the contact with the circumference of the disc; he furthermore assumes that the difference between the equilibrium rate and the actual rate is proportional to the deflection on reversal. He gives the results of some tests showing a mean divergence in the value of the resistance, of about one part in 12,000; he also gives results of a number of determinations of the international ohm in absolute units showing that no single observation differs from the mean by more than one part in 10,000. He describes how the dimensions of the coil and disc may be measured with great accuracy; to avoid the error introduced by the silk winding of the wire, he recommends using bare wire wound on insulating material, say, paraffined marble. He believes that by this means resistance can be measured to an accuracy of one part in 10,000 and that therefore there is no valid ground left for adopting as an ultimate unit of resistance any other than the absolute unit and he considers that it is necessary that it should be done. The method is specially applicable for measuring low resistance, for which a sufficiently large current must be used. The lecture is discussed editorially and praised very highly in Lond. "Elec.," June 14.

Measurement of Very High Voltages.—In an article by Messrs. Abraham and Lemoine in "L'Eclairage Elec.," June 8, they describe and illustrate two forms of absolute electrometers, one for use as a standard and the other less accurate but more easily used. The chief difficulty in measuring high voltages is the necessity of keeping the voltage constant long enough to measure it; this was accomplished with the aid of a sort of electrical "overflow" (trop-plein) through which there is a constant flow between two conductors, the source, an influence machine, being run at a very regular speed; these conductors should terminate in very fine points and the machine should run by means of a dynamo taking current from accumulators; the overflow is also connected by means of a poor conductor to a somewhat large Leyden jar, which will then be charged with a constant difference of potential; with these devices voltages from 1,000 to 100,000 can be measured, the results being based between 5,000 and 40,000 volts. The electrometers are based on the well-known principles established by Lord Kelvin; a plate surrounded by a guard ring is suspended from one arm of a balance over a second plate, the attraction being measured by means of weights; the measurements are accurate to one-thousandths; the simplified apparatus is of the same general form and measures to one part in 100.

Measuring Internal Resistance of a Cell with Current.—Referring to the recent article by Prof. Carhart (see Digest, March 30 and April 27), Mr. Uppenborn, in the Lond. "Elec. Rev," June 21, states that he described a method in the "Elek. Zeit.," March 20, 1891, page 157, by which the internal resistance and current may be measured simultaneously; he believes that Carhart's method is not as suitable, as accurate results can be obtained only with the aid of peculiar artifices.

Apparatus for Measuring Phase Difference.—The paper by Mr. Dell, which was abstracted in the Digest, April 6, is reprinted in "El'ty," June 26, with the illustrations.

TELEGRAPHY, TELEPHONY AND SIGNALS.

History of the Telephone.—In the "Elec. Eng.," July 3, Mr. Suess replies to the recent communication of Prof. Dolbear (see Digest last

week). In 1854 an article headed "Electrical Telephony" was printed in a prominent paper in the city in which Reis lived, giving a full account of Bourseul's make-and-break transmitter and magneto-receiver; five years later Reis made an apparatus as the one described, and obtained musical notes "together with what at rare intervals appeared like a semblance of human speech"; for this instrument he coined the word "Telephone," which the present writer calls a remarkable coincidence with the heading of that article printed five years before. Regarding the claim that Hughes was the first to use hard carbon, he states that Berliner on Sept. 10, 1877, showed the "combination of a plate of hard carbon on a vibratory electrode in loose contact with a vibratory metal electrode, an embryo Blake transmitter contact"; Edison must have antedated this by several weeks, as he won the interference case; six months later came Hughes with "large noise and great pretensions"; he coined the word "microphone," mistaking the incidental admixture of foreign sounds with the one to be transmitted, for an increase of the latter and without considering that he merely brought the sound closer to the ear drum.

MISCELLANEOUS.

Indicator of Lightning Discharges.—A new and slightly modified form of the instrument which was described in the Digest some time ago is illustrated in the "Elek. Zeit.," June 13; quite a large number of these are now in use in Germany. The instrument is attached to a lightning rod and consists of a star-shaped horizontal disc pivoted at its centre and magnetized in one direction; when a lightning discharge passes through the rod it shifts the direction of magnetization, after which the disc will take a different direction due to the earth's field; the change of its position indicates that a discharge has passed through the rod.

Indelible Marking of Linen.—According to the Lond. "Elec. Rev.," June 21, the following process was exhibited by Nalder at the Royal Society Conversazione. The name or design to be marked is made in high relief on a silvered die, the fabric, dampened with a solution of common salt, is placed on a carbon plate connected to three or four Leclanche cells and the die, which is connected to the other terminal, is pressed on the fabric for two seconds, carrying some of the silver into the fabric, after which the current is reversed for three seconds which is claimed to reduce the silver to a metallic state, leaving an indelible impression.

Japan.—According to the "Elec. Friend" (Japan) for May, the fourth national exhibition of Japan is being held at Kioto from April to July; a list of the electrical instruments and apparatus is given but they are not very numerous. The seventh anniversary of the Japanese Electric Light Association was held at Kioto on May 10. The same journal contains a translation into Japanese of an article on the life of Chas. F. Brush.

Electro-medical Plant.—An illustrated description of the plant at the Vanderbilt Clinic, New York City, is given in "Elec. Power" for June by Mr. Freedman. The generator is a two-hp dynamo having a double wound armature, one for a 10 and the other for 110 volts; the currents are required for cauteries up to 30 amperes, a constant direct current from 0 to 400 milli-amperes and an alternating current which can be regulated and whose frequency can be varied. With the cautery a resistance box is used which is constructed of small carbon pencils one quarter in. in diameter and four in. long, having a maximum of 10 and a minimum value of 0.2 ohms; for the direct current a keyless incandescent lamp is always in circuit while another with a key may be connected in parallel with it; the alternating current is produced by an induction coil whose secondary is tapped at several points at which connection may be made; this circuit contains a Vetter rheostat whose action is gradual, continuous and reliable; it consists of a quantity of finely divided carbon powder in a rubber cylinder between two plates, one of which is forced down on the carbon, which bulges the rubber cylinder outward diminishing the amount of carbon and the distance between the plates; the induction coil is provided with an "apron" consisting of a brass clyinder which can be slid between the primary and secondary coils for regulating the action.

Fiske Position Finder.—An illustrated description of the new position finder is published in the "Elec. Eng.," July 3; little is said of the actual description of the instrument itself; it differs from the range finder in that it locates upon a chart the position of the target with its distance and direction from some given point, usually though not necessarily one of the instruments of the position finder (from which it appears that there must be more than one instrument although this is not explained); the range finder simply finds the distance of the target from itself. Tests of this instrument were made by the government at Ft. Hamilton with two stations about 2,100 yards apart, which were connected by telephone; it appears to consist of a telescope over a table containing a chart; the results of the tests are not yet known. Range finders (whether this or other kinds, is not stated) are used largely in Europe; they are based on the solving of a right-angled triangle of which one side is the height of the instrument above the water and they work with considerable accuracy when the height is sufficiently great to form a good base. What there is electrical about the instrument is not described except that two distant telescopes are connected by telephone.

Biographical.—"Elec. Power" for June contains an illustrated character sketch of Mr. Wm. Henry Preece, of London, by Mr. Webb.

New Book.

ARMATURE WINDINGS OF ELECTRICAL MACHINES. By H. F. Parshall and H. M. Hobart. New York: D. Van Nostrand Company. 350 quarto pages, 129 diagrams, 67 tables. Price, $7.50.

As the title suggests, this work is a compilation of data descriptive of the many types of armature windings currently employed in engineering practice. The book is divided into three parts. Part I. treats of continuous-current windings and includes single and multiple-wound Gramme rings; two-circuit multipolar ring windings, single and multiple-wound; bipolar drum windings, two circuit and multiple-circuit; single and mutiple-wound drums; interpolated commutator segments and connections; rules for re-entrant windings and a description of the Sayers winding. This section is illustrated by 76 diagrams.

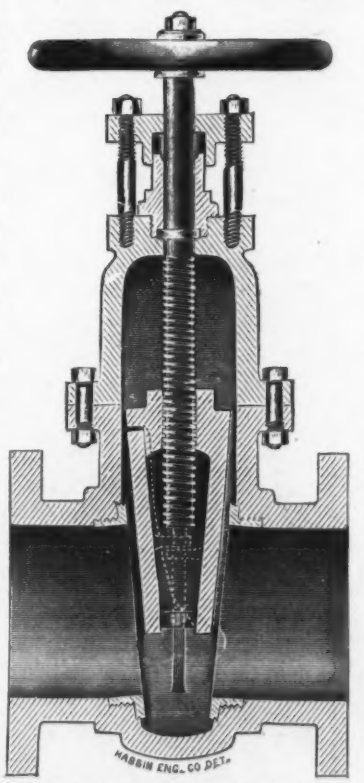
Part II. is devoted to alternating-current windings and discusses the special considerations involved in the design of such windings. Descriptions and diagrammatic representations are given of multi-coil and single-coil windings; iron-clad and smooth-core construction; alternating-continuous-current commutating machines; simple alternating and two and three-phase windings; interchangeable simple and multiphase windings; coils for segmental armatures; ratio of collector-ring to commutator voltage in two-phased continuous-current and three-phased continuous-current machines; and induction motors.

Part III. contains winding formulæ and armature-winding tables.

The book will be found of great convenience by practical designers, though many of the winding methods are corroborated and duplicated unnecessarily and not a few diagrams and descriptions are inserted which might have been dispensed with so far as the needs of the designer are concerned, and which constitute more of an historical record than an assistance. Otherwise the work is thoroughly practical and up to date in every respect. The diagrams are clear and the explanations concise and simple. Alternating-current windings are treated exhaustively, and these descriptions and diagrams constitute a valuable feature of the book. Of special value, also, are the winding tables, which give at a glance the proper pitch corresponding to any given number of conductors from 102 to 1,600, on four to 16-pole drums, and with any of the standard windings commonly used. The book is printed in large type on excellent paper and very substantially bound in cloth.

A Heavy Duty Gate Valve.

We illustrate herewith an extra heavy gate valve manufactured by the Roe & Stephens Manufacturing Company, Detroit, and known to the strade as the Scott valve, a notable feature of which is the peculiar contruction of the patent cylindrical wedge, giving full circular bearing upon the back of the disc or gate, and, it is claimed, ensuring a perfect seat and obviating the possibility of the disc or gate getting out of shape. The discs are raised by their lugs coming in contact with corresponding shoulders on the wedge, and the arrangement of the lugs is such that one disc slightly rotates upon the other, so that the least movement of the stem releases that disc slightly in advance of its mate, enabling the valve to open easily under heavy pressures.



EXTRA HEAVY GATE VALVE.

These valves have no special inlet sides, and can be connected horizontally, vertically or otherwise and with either side to the pressure. All threads are cut square and all parts are interchangeable. The manufacturers furnish these valves in all sizes from two and a half to 12 inches and guarantee them for working pressures of 200 to 300 pounds. All the wearing parts are made of a special bronze and the seats are screwed in. The valves are tested up to 1,000 pounds pressure and have the reputation of giving entire satisfaction wherever used.

Electric Welding in Ships.

According to British rules, while a boiler furnace might be electrically welded from end to end with approval by the government departments supposed to concern itself with the safety and efficiency of marine engines in vessels carrying passengers at sea, yet on no account must the smallest portion of the steel-working parts of a marine engine be electrically welded if the structure is to obtain a passenger certificate.

The Baltimore & Ohio Electric Belt Line.

The inaugural address of Dr. Duncan, printed in our last issue, describes the general features of the electric plant of the Belt Line tunnel of the B. & O. Railway, and we are enabled to present herewith some further information, accompanied by illustrations of the locomotives and line construction.

The power house is a one-story building rising 30 feet from floor to eaves, and is divided into two parts, the engine room occupying the north portion, being separated from the boiler room by a brick wall. The entire length of the building is 322 feet 1 inch long; the dimensions of the engine room 223 feet 10 inches in length by 57 feet 9inches wide, and of the boiler house 98 feet 3 inches by 69 feet wide. The boiler house contains 12 boilers (250 hp) arranged in six batteries, three of which are placed on each side of the centre passage. The boilers are of the Root water-tube type, from the shops of the Abendroth & Root Manufacturing Company. Each boiler is 12 tubes wide and 11 tubes high, with six 14½-inch drums and a 30-inch steam drum. A system of fan draught is employed, one of two 10-hp Sturtevant fans furnishing the necessary pressure. The boiler room is further equipped with a C. W. Hunt coal crusher and conveyor, which brings the coal to the boiler and carries away the ashes from the ash pits, with Deane duplex pumps, and a 3,000-hp Webster feedwater heater.

The engine room is divided into two sections, one devoted to the power plant, the other occupied by the lighting generators. In the power section space has been provided for five direct-connected engines and generators, and four are now in place. The engines are 500-hp horizontal tandem-compound Reynolds Corliss machines, from the shops of E. P. Allis & Co. Directly coupled to the engines are 500-kw General Electric multipolar generators, adapted to run with the engine at 110 revolutions per minute. The armatures of these generators are "overhung" on the outer end of the shaft, the arrangement, in this respect, differing from the regular practice of railway generators. The armatures also differ from standard practice in being wound for 700 volts potential, and are of the iron-clad type, *i. e.*, the windings are embedded in slots cut into the outer periphery of the laminated armature body. The armatures are of the latest barrel wound type, and present a very massive appearance. The fields are of steel and run remarkably cool. The machine compounds from 600 volts no load to 700 volts full load. From the railway generators the current is brought over cables of 1,000,000 circ. mils cross-section, to a switchboard of white marble, erected on a platform raised at the south end of the engine room.

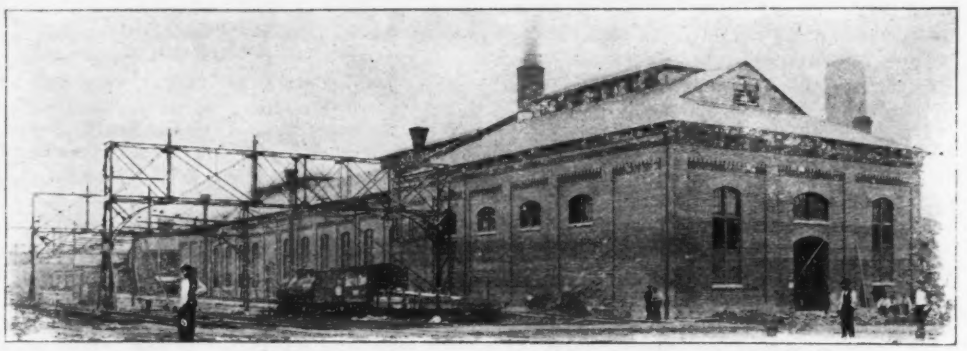


FIG. 1.—VIEW OF THE POWER HOUSE.

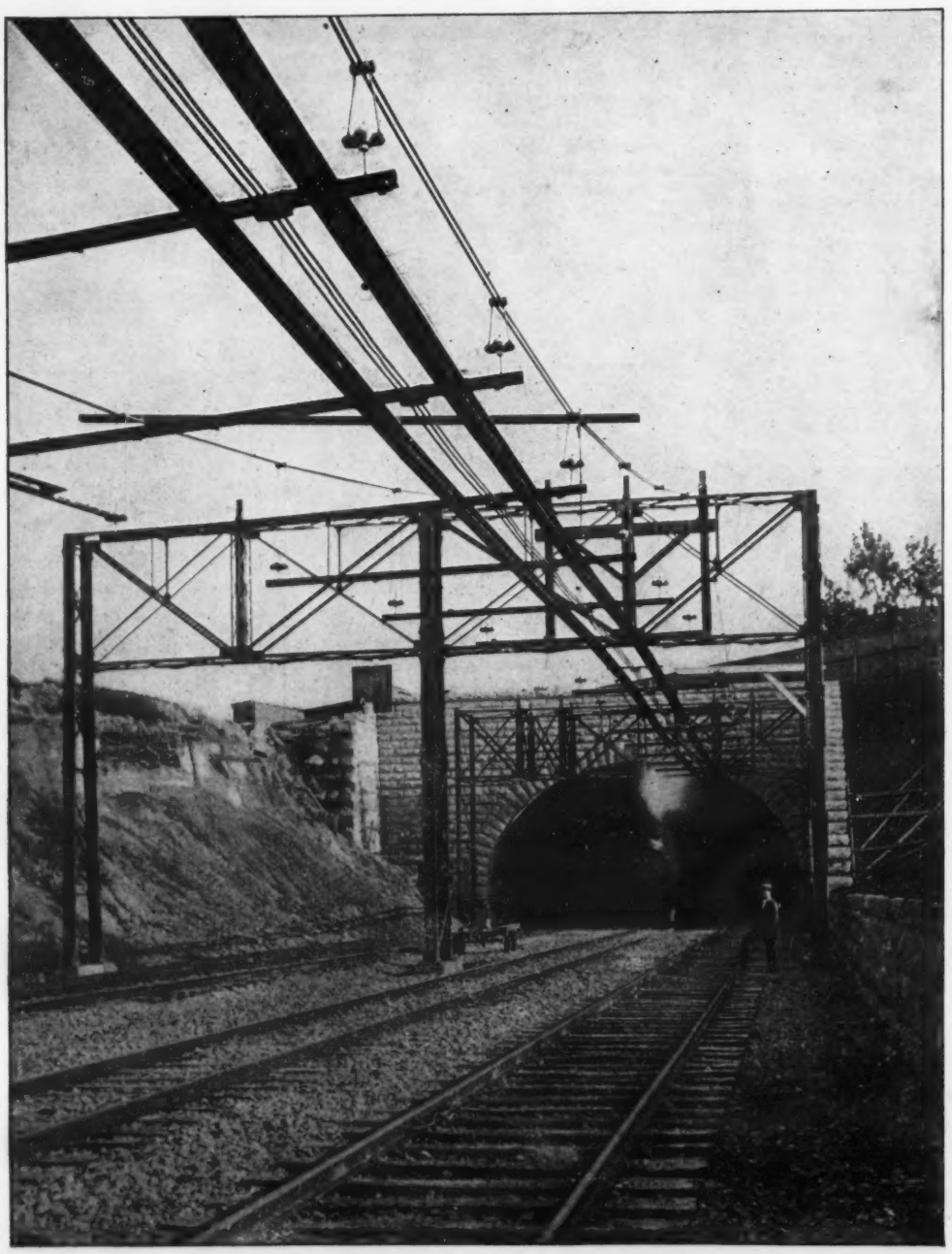


FIG. 2.—THE ENTRANCE TO THE TUNNEL.

The northern section of the engine room contains the lighting plant, consisting of eight 50-light Thomson-Houston arc generators, and two alternators, for the incandescent lamp service in the tunnel. The arc light machines are belted to two cross-compound Armington & Sims 250-hp engines, 16½ x 23 x 19 inches. Two other engines, of similar make and capacity, drive the two alternators, and space has been left for an additional engine and alternator. Each alternating generator has a capacity of 2,000 16-cp lamps, and as the tunnel is lighted by 1,000 32-cp lamps, one alternator will suffice for the present illumination of the tunnel. Facing the lighting plant, on the east side of the room, is the lighting switchboard, also of polished white marble. The arc lamps used in the illumination of the power house are of the Thomson 1893 type. In addition, it is lighted by clusters of three incandescent lamps each, fixed to the walls. The approaches and stations are lighted by Thomson-Houston standard arc lamps.

From the positive bus on the railway switchboard, eight cables of stranded copper, each of 500,000 circ. mils cross-section, or a total cross-section of 4,000,000 circ. mils, pass to the overhead structure immediately outside the power house, where connection is made to three feeder cables, of 1,000,000 circ. mils cross-section each, and to the overhead conductor itself, which has an equivalent of 1,000,000 circ. mils cross-section. The negative bus is similarly connected to the rails, which are double bonded with No. 0000 wire, and also to the return cables, laid in a wooden box between the tracks. Perfect contact between bonds and web is obtained by using a hollow rivet on each end of each bond and expanding it, when inserted in the rail, by means of a conical steel pin.

The distance over which the electrical locomotives will operate is about 15,000 feet, passing through two tunnels, 7,339

feet and 265 feet long, respectively, and over 7,396 feet of track in the open from Hamburg Street to Huntington Avenue. The operation of freight trains will begin at the main tracks south of the Camden station, where they will be switched into the cut. The electric locomotive will then couple on behind, without stopping the train, and push it through as far as the Mt. Royal Avenue portal, a distance of 8,146 feet, the steam locomotive doing no work. After passing out of the tunnel, both steam and electric locomotives pull and push together up the heavier grade as far as Huntington Avenue, the average speed over the entire distance being about 15 miles an hour. At Huntington Avenue the electric locomotive will uncouple and run into its siding. The plan of pushing the passenger trains through the tunnels has been abandoned, in view of the possible results if one of the cars or the steam locomotive should leave the track, in front of the heavy electric locomotive traveling at 30 miles

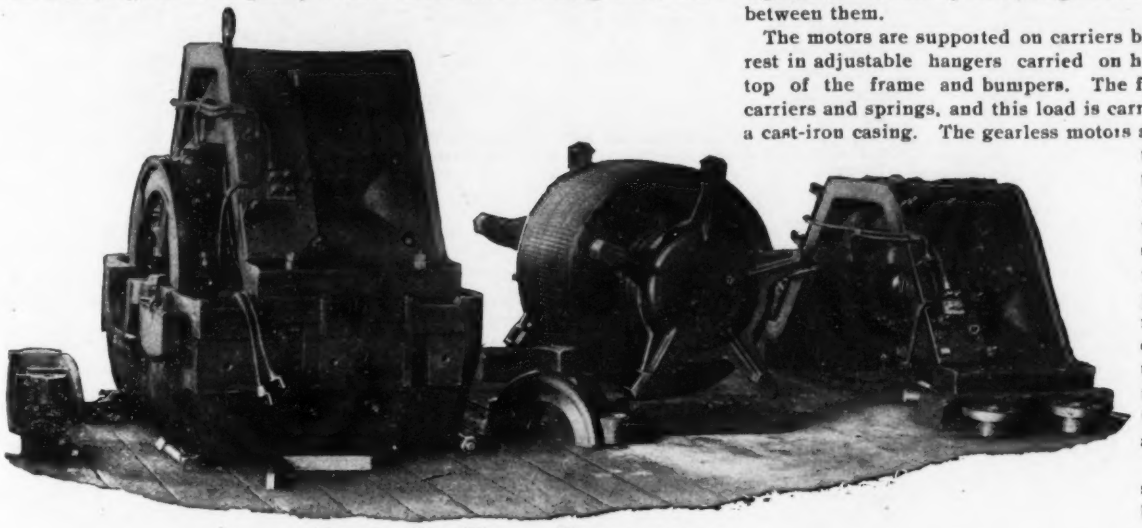


FIG. 3.—THE MOTOR, UNASSEMBLED.

an hour. The passenger trains will, therefore, be pulled through from the Lombard Street station, near the south end of the tunnel, to the Bolton Street station at the north end.

The dimensions of the locomotive are as follows:

Number of trucks	2
Number of motors	4—2 to each truck.
Weight on driving wheels	192,000 lbs. (96 tons).
Number of driving wheels	8
Drawbar pull	42,000 lbs.
Starting drawbar pull	60,000 lbs.
Gauge	4 feet 8½ inches.
Diameter of drivers	62 inches outside of tires.
Length over all	35 feet.
Height to top of cab	14 feet 3 inches.
Wheel base of each truck	6 feet 10 inches.
Extreme width	9 feet 6¼ inches.
Diameter of sleeve bearings	13 inches.

The driving gear consists of a cast-steel spider, shrunk on and keyed to a cast-steel driving sleeve, having a tensile strength of not less than 80,000 pounds. Each arm of the spider is provided with a double rubber cushion, with a chilled cast-iron wearing cap, the cushion being forced into the arms of the spider and the cap. The eight driving wheels are of cast steel pressed and keyed to the axles, and have tires three inches thick at centres of tread shrunk on to the wheel centres. The driving axles are of special open hearth steel. The journal bearings are outside the driving wheels and allow of easy access to all parts of the truck frame and driving box. The two opposite side frames of each truck rest upon four wheels, each consisting of one piece of hammered wrought iron, three and a half inches thick, to which the frame jaws are welded, and protected from wear by cast-iron shoes, and are connected together at the ends by heavy forged iron plates, with oak bumper beams between them.

The motors are supported on carriers bolted to the field magnets, and rest in adjustable hangers carried on half elliptical springs placed on top of the frame and bumpers. The frames thus carry the motors by carriers and springs, and this load is carried in turn by rubber blocks in a cast-iron casing. The gearless motors are four in number, two to each truck, flexibly supported and transmitting their power to the wheels through flexible connections. They are of pyramidal shape, are the largest railway motors in the world and, while ponderous in appearance, are by no means so bulky as might be expected from the heavy work they have to perform. Each motor is rated at 360 hp and takes a normal current of 900 ampères.

Each has six poles and six sets of carbon brushes, the brushes being connected to a yoke revolving through 360 degrees to facilitate accessibility to them. It is possible to remove four brushes without disabling the motor. The field spools are encased in sheet-iron cases and fitted over the pole-pieces bolted to the field frame. The armatures are built of sheet-iron laminations, and are series drum wound. They are known as iron-clad, each insulated winding being embedded in an insulated slot cut into the outer surface of the armature body, and held therein by a wooden key. This armature, with the commutator, is mounted upon and keyed to the hollow sleeve which is carried on the journals on the truck frame. The inside diameter of the sleeve is about two and a half inches larger than the axle. The entire motor is practically fireproof.

When normally placed the motor rests in a position concentric to the axle, the clearance between the axle and the sleeve allowing of a flexible support. The interposition of the rubber cushions, through which the torque of the armature is transmitted to the driving wheels, allows the armature to run eccentric to the axle, when the motor departs from its normal position on account of any unevenness in the track. The motor

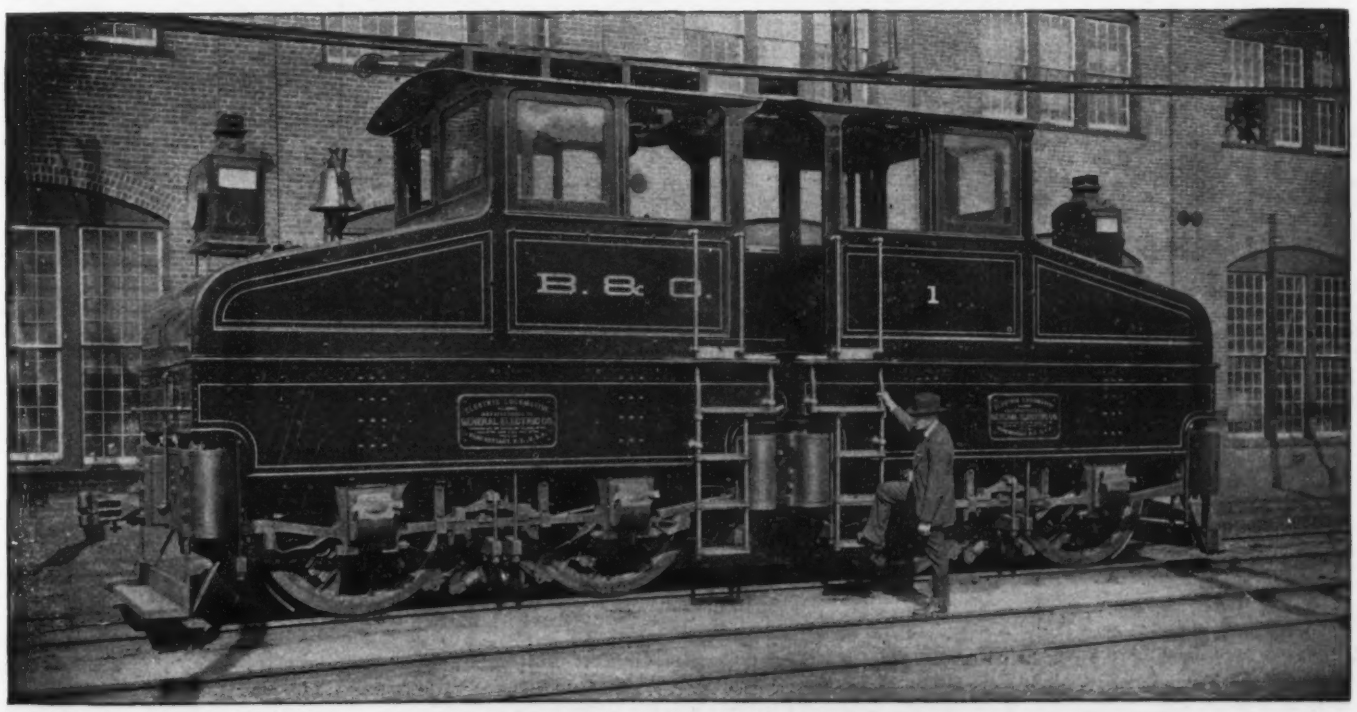


FIG. 4.—THE ELECTRIC LOCOMOTIVE.

is designed to allow of ready removal of the field frame for inspection or repair.

A test of the first completed truck, representing one half of the locomotive, was made upon the tracks at the Schenectady shops of the General Electric Company. In order to obtain the necessary load, a heavy six-wheel engine was made use of and the electric locomotive truck coupled to it. The machines were then sent in opposite directions

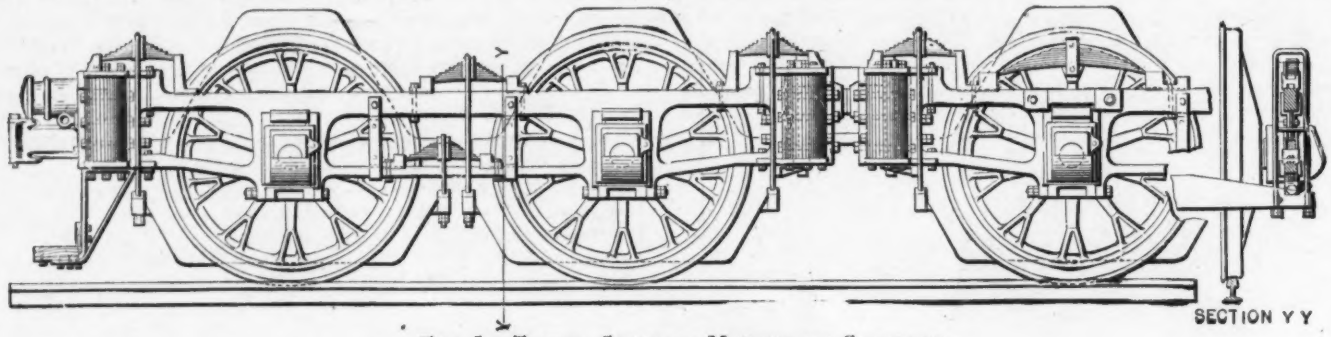


Fig. 5.—Truck, Showing Method of Coupling.

and tugged at the connecting coupling as in a tug of war. The electric locomotive had a slight advantage over the steam engine in weight on the driving wheels, and pulled it up and down the track with apparent ease. For the same weight upon the drivers it was shown that the electric locomotive starts a greater load than the steam locomotive. The pull being constant throughout the entire revolution of this wheel, the difficulty of variation of pull with the angle crank, as in the steam

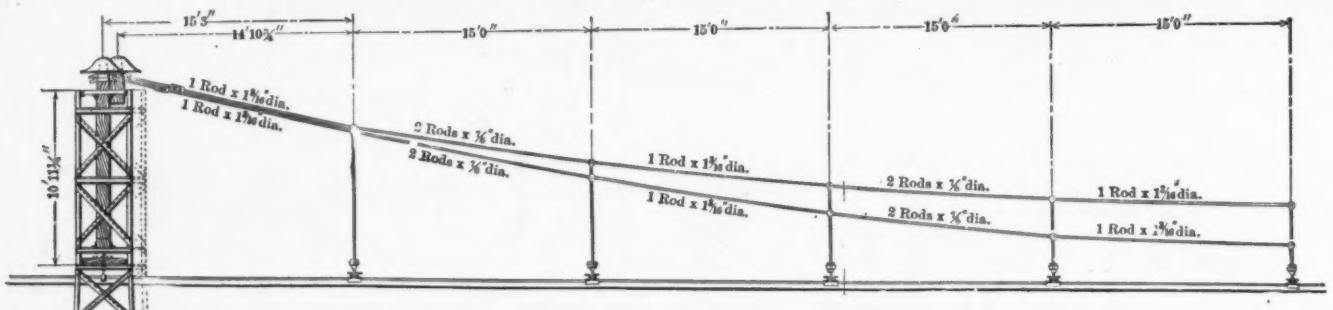


Fig. 6.—Elevation of Span on Curve.

locomotive, is eliminated. The test also proved that not only are the motors sufficiently powerful, but that the driving mechanism and armature couplings are amply strong to transmit the torque of the armature to the axle.

The controlling devices and measuring instruments, etc., occupy the interior of the cab. The controller is erected in one half of the cab, and is of the series-parallel type. The reversing lever projects through the tive. The interior of the cab is illuminated by clusters of incandescent lights.

Contact with the overhead conductor is effected by means of a sliding shuttle-like shoe of brass, which is fixed to a flexible support fastened to the top of the cab. This "trolley" support is diamond shaped and compressible, contracting and expanding as the height demands, and is arranged to lean on one side or the other as the locomotive runs on one side or the other of the overhead conductor. It is, however, right in so far as movement forward or backward over the locomotive is concerned. The current is brought to the locomotive by means of cables connected to the shoe and fastened to the trolley support.

The conductor is simply a reversed iron conduit or trough erected overhead on trusses in the open, and in the tunnel attached to the crown of the arch. In the open the conductor is directly over the centre of the tracks; in the tunnel it is over the centre line of the space between the tracks. It extends from Henrietta Street on the south to Huntington Avenue on the north, a distance of 15,000 feet.

The conductor consists of two 3-inch iron Z bars three-eighth inch thick, riveted to a cover plate one-fourth inch thick and 11½ inches wide, and is constructed in sections 30 feet long. It weighs about 30 pounds per foot. At intervals of 15 feet inside the tunnel there are

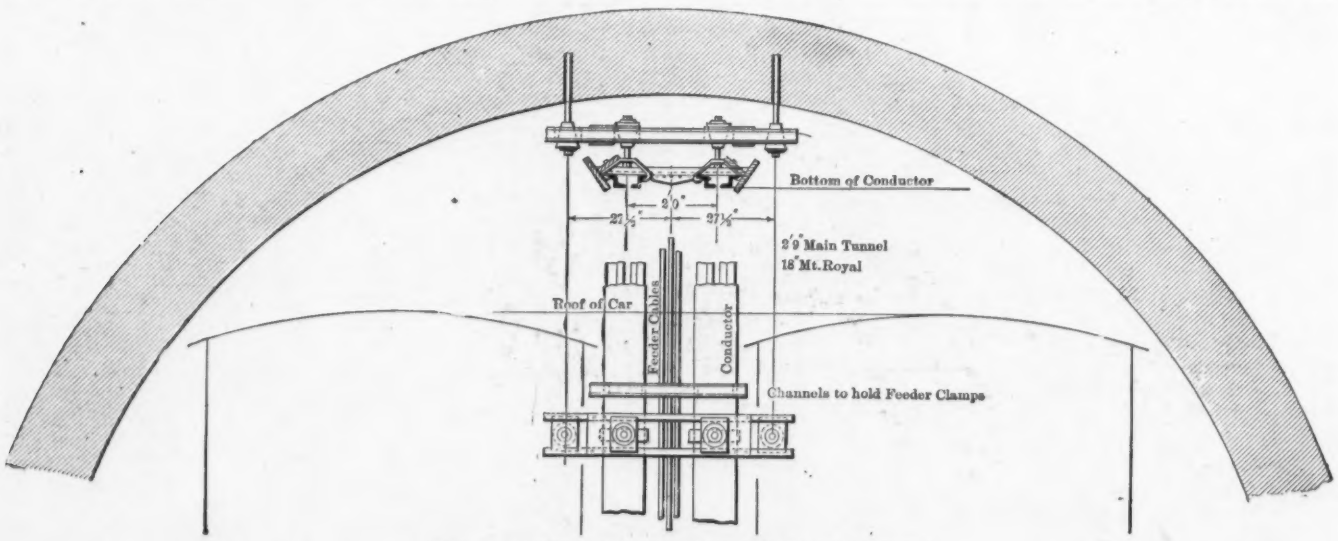


Fig. 7.—Section Through the Main Tunnel.

upper plate of the controller cover. The resistances are placed around the frame beneath the floor of the cab.

The locomotive is equipped with a 1,200 to 3,500 ampere automatic circuit-breaker and one 2,000-ampere magnetic cut-out, a 5,000-ampere illuminated dial Weston ammeter and a Weston voltmeter. The compressed air for the whistle and brakes is supplied by an oscillating-cylinder electric air-pump, the air tanks being placed at each end of the complete locomo-

suspended from the arch transverse frames, consisting of two 3-inch channels, held together by plates 4 inches wide, and holding four castings into which are fitted conical porcelain insulators. In the masonry of the tunnel are fitted the bolts necessary to support these frames. They are 2 feet 6 inches long, have split ends, and extend 12 inches into the masonry. The bolts pass downward through the outside pair of insulators. The bolts attaching the conductors to the channel frames pass

through the inside pair of insulators and support an iron stirrup in which the conductor hangs. This method affords a double insulation, and if leakage occurs it can only be by the current passing the insulators between the conductor and the transverse channel, and then the insulation between the channel and the bolt in the tunnel arch. There may be a defective insulator either on the roof bolt or on the bolt which supports the conductor, but only when two insulators on the same transverse channel frame are defective will leakage occur. The height of the conductors above the level of the top of the rails is 17 feet 6 inches in the tunnel, and they are fixed a little on each side of the centre line. This plan was adopted to avoid the risk of the conductors striking brakemen who might be standing on the top of passing freight cars. An additional precaution is provided in the shape of continuous wooden shields fastened to the iron stirrup which supports the conductors.

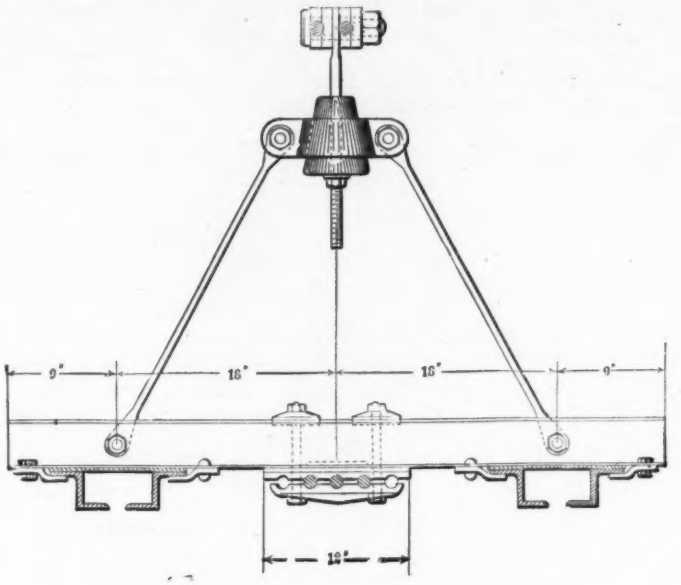


FIG. 8.—SECTION THROUGH TANGENT SUSPENSION.

Outside the tunnel the height of the conductors above the rails is increased to 22 feet. The supporting structure in the open consists of longitudinal catenaries of two chains of iron rods, having a span of 150 feet, suspended from transverse trusses, supported by columns of latticed steel channels erected on either side of the double track. The catenaries pass over the top chord of the transverse trusses, and are fastened to a yellow pine timber post, acting as an insulation, set therein. From the joints in the catenaries vertical rods are dropped at intervals of 15 feet to support the electrical conductors. The vertical rods are attached to a casting holding a porcelain insulator, and through this a short bolt passes up to the joint in the catenary. The double insulation is secured by this vitrified porcelain insulator and the timber post, passing vertically through the transverse girder. A hood of galvanized iron is fixed to the top of the timber post. At the ends of the line an anchor pier receives the ends of the conductors. The trusses vary in length from 30 feet to 62 feet, the latter being required to span five tracks.

Upon the straight track the conductors are suspended from single catenaries, while upon the curves a double catenary is employed, and the conical insulator is inverted and supported in a casting bolted to the two vertical rods which drop from the catenaries. The vertical rods support a channel frame, to which are bolted the conductors and the feeder cleats or clamps. Each joint of the conductor is bonded with a Chicago bond of two No. 0000 wires.

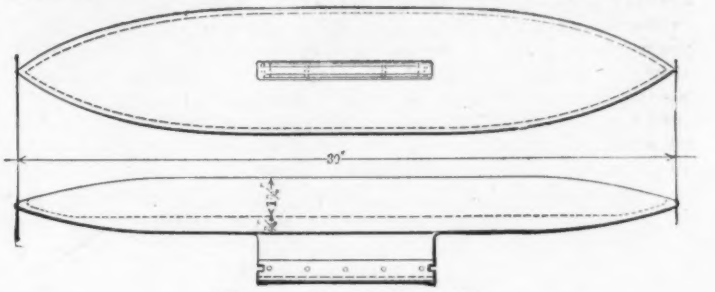


FIG. 9.—TROLLEY SHOE.

The feeder cables are of bare stranded copper of 61 strands each of 1,000,000 circ-mils cross-section. These are supported in iron cleats fastened to channel frames riveted to the overhead conductors at points near to the heavier channels to which the conductors are suspended.

The lead covered primaries for the tunnel lighting plant are carried on posts set on the side of the cut, to the southern portal, where they drop to the tunnel and are carried upon porcelain knobs fastened to wooden blocks bolted to the masonry. At the points of support the cables are armored with wire to prevent abrasion. The secondaries are carried in cleats, also fastened to wooden blocks, similarly attached, and placed on either side of the tunnel about eight feet from the ground and 15 feet apart. They are, however, staggered, and thus occur alternately at every seven and a half feet throughout the tunnel. Each block carries a lamp at its lower end, and is there cut out so that the lamp socket may be protected from moisture and dripping water from the tunnel walls. The lamps used are 32 cp, 52-volt Edison standard incandescent lamps.

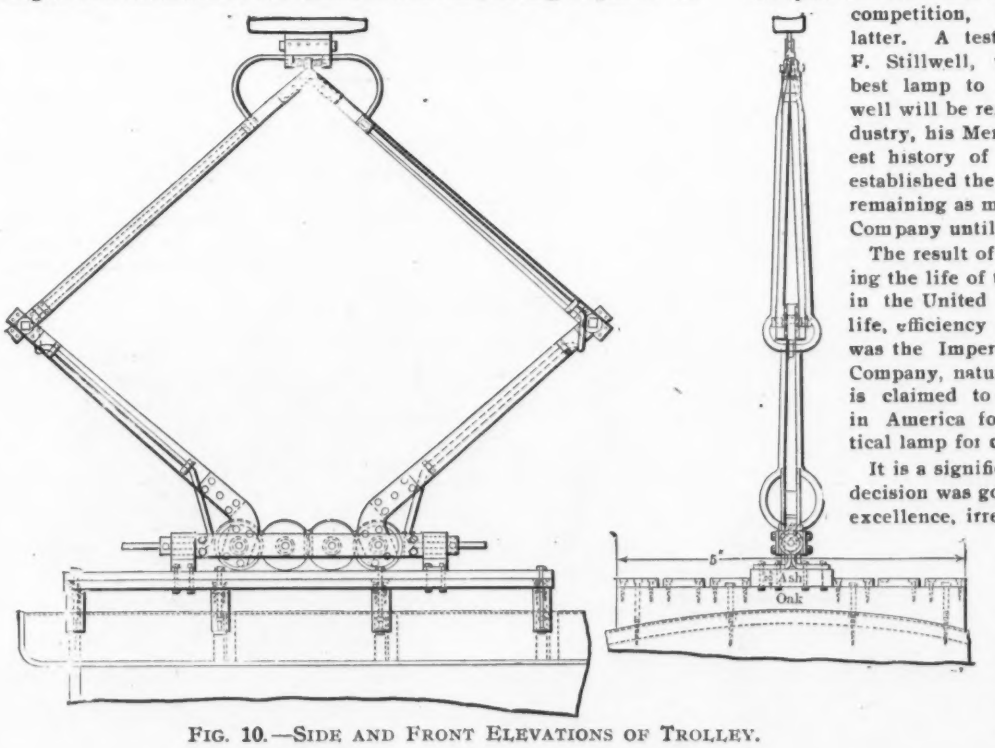


FIG. 10.—SIDE AND FRONT ELEVATIONS OF TROLLEY.

An International Lamp Test.

European and American incandescent lamps have lately come into competition, with results rather favorable to the latter. A test was recently conducted by Mr. Charles F. Stillwell, whose only interest was a selection of the best lamp to offer his Canadian customers. Mr. Stillwell will be remembered as one of the pioneers in the industry, his Menlo Park experience dating back to the earliest history of the business, while in more recent years he established the Canadian factory of the Edison Lamp Works, remaining as manager under the Canadian General Electric Company until a comparatively recent period.

The result of his rather exhaustive tests, continued during the life of the lamps, was the selection of a lamp made in the United States, as combining in the highest degree life, efficiency and lasting brilliancy. The lamp selected was the Imperial, whereat the maker, the Bryan-Marsh Company, naturally is highly gratified, as the competition is claimed to be the broadest in scope ever entered into in America for the purpose of ascertaining the best practical lamp for commercial usage.

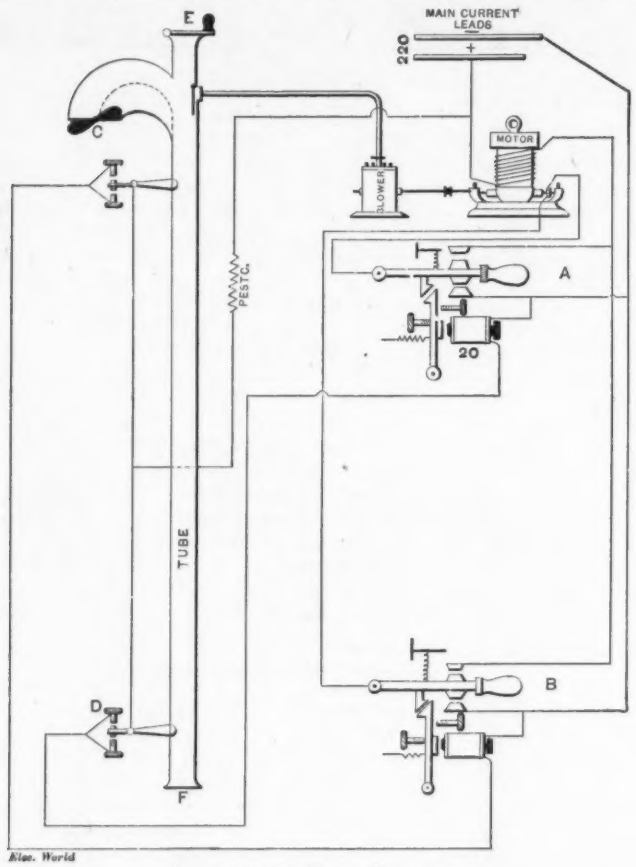
It is a significant sign of the times that Mr. Stillwell's decision was governed solely by the consideration of highest excellence, irrespective of the initial cost, and this point is no less a potent sign of reviving prosperity. In times of depression the demand for low prices was the ever prevailing theme, but this has been properly supplanted by requirements considering excellence and *ultimate* cost of product. Nowhere are the latter qualities entitled to more thought than in the installation of incandescent lamps.

Water Tube Boilers.

An English contemporary states that the advantage of the water tube boiler is that it can get up steam quickly by reason of the smallness of its water contents, but it is not found to be capable of being heavily forced, producing very wet steam under such conditions. Experience, however, has shown that with the addition of a drier such boilers can be forced heavily, the heavy priming being unable to live through the drier.

An Electro-Pneumatic Tube System.

The accompanying diagram illustrates the principle of a new application of electricity to the operation of pneumatic tubes. There are very many plans where a tube is required between one part of a building and another, as, for instance, between the receiving and delivery counters and the operating room of telegraph offices where there is not such a continuous stream of traffic as to require two tubes. The system shown in the illustration permits carriers to be dispatched in either direction through one tube, and is operated by an electric motor connected to either the inside or outside electric light or power wires of the building. No energy is consumed except when a carrier is in transit, and no time need be wasted by the attendant. When a carrier is started from *E*, the attendant inserts it in the tube and closes lever *A*, which closes the circuit in one direction through the series motor operating the blower,



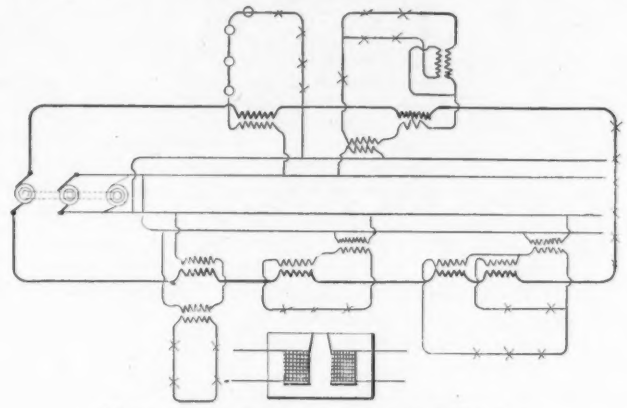
Pneumatic Tube System.

which drives the carrier to *F*. In passing *D* the carrier closes a local circuit that energizes an electromagnet at *A*, automatically opening the motor circuit. This operation is reversed when the carrier is started from *F*. The attendant closes lever *B*, which closes the circuit of the motor, the current being thus reversed in its fields, and rotates the blower in the opposite direction, drawing the carrier by suction to *E*. Just before reaching *E* the carrier moves a lever at *C* that extends inside the tube through an air-tight slot and thus closes the electromagnet at *B*, opening the motor circuit. This extremely economical arrangement has been recently patented and is being put in use by Mr. Gilmer Crowell, of Brooklyn.

New Alternating-Current System of Distribution.

A patent was issued June 18 to Mr. Charles K. Huguet, of New Orleans, La., for a system of distribution of alternating currents. The object of the invention is to supply to each of one or more different branch circuits an alternating current of constant strength from a source of alternating currents of constant potential. It includes the use of a plurality of alternators, part of which are arranged to furnish currents of constant potential and others to furnish currents of constant strength; the machines being arranged to run in synchronism, but with a difference of phase of exactly one-half-period between the impressed E. M. F. of the two systems, this relation being termed "running in anti-phase." The invention further includes the use of transformers, one coil of each transformer being connected in a constant-current circuit, and the other coil being connected in a branch from the constant-potential circuit containing also lamps or other devices; or a second coil of the transformer may be in the secondary circuit of still another transformer or primary which is actuated by a current in a branch from the constant-potential alternator.

The accompanying diagram shows the various ways of connecting up the translating and distributing devices. So long as the total impedance of the consumption circuit remains constant the lamps will consume a constant volume of current without assistance or regulation from the transformer. If, however, from any cause whatever the impedance varies the volume of current would also vary were it not for the regulating action of the transformer, which action is claimed to practically prevent such a change; this follows from the fact that the second coil of the transformer carries a current of opposite phase always, tending to magnetize the core in the opposite direction from the first current, each current will hinder itself and help the others. It is further evident that if each coil has the same number of ampere-turns, each current will be helped by the other in the same degree as it hinders itself, so that the core will remain unmagnetized, and each circuit will be as though it was independent of the other and no transformer in the circuit. As the impedance varies the balance is disturbed in the transformer,

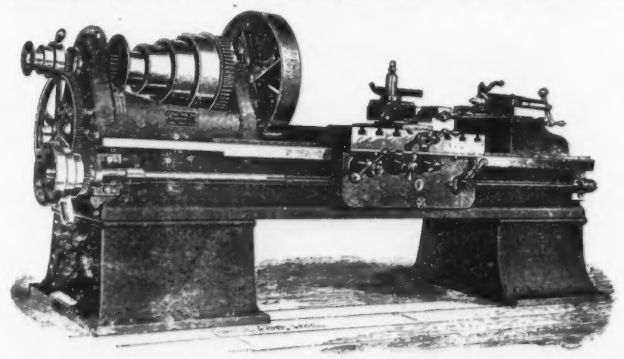


New Alternating Current System.

and the core becomes somewhat magnetized by the excess of ampere-turns in one coil, which tends to choke the increasing current in the consumption circuit and to help the current in the constant-current circuit; if the *c. c.* dynamo had no current regulation the current in its circuit would increase until the core of the transformer was again demagnetized, but it is an essential part of the invention that the dynamo should regulate for constant current, as before stated, so that the E. M. F. of the dynamo drops sufficiently to maintain the current constant, therefore the surplus energy in the lamp circuit beyond the normal is now transferred to the *c. c.* circuit where it does useful work, the alternator delivering a correspondingly less quantity of energy.

A New Engine Lathe.

The accompanying cut represents an entirely new engine lathe which has just been put on the market by the Fifield Tool Company, Lowell, Mass. The lathe swings 26 inches over the ways and has a 12-foot bed, but can be furnished with any length of bed up to 30 feet. The spindle is of forged cast steel 3¼ inches in diameter; the bearings are large and strongly constructed, and the head is heavily back-geared. The gears are cut from solid steel and are unusually massive and smooth-running.



New Engine Lathe.

The lathe is provided with friction and positive feeds and power cross-feed. The carriage is stiff and strongly gibbed; it has a compound tool rest and has a solid bearing on the ways of 34 inches. The weight of the lathe is 5,100 pounds, and with a 12-foot bed it takes seven feet between centres.

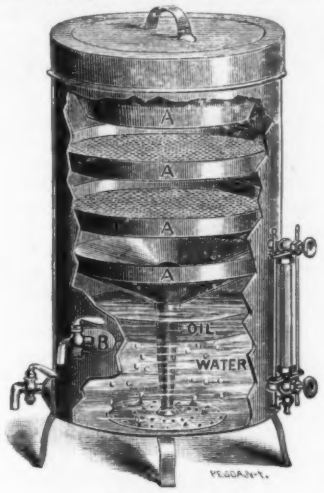
The Fifield Tool Company makes other sizes and styles of lathes up to 64 inches swing.

Water Power in Northern Italy.

Three schemes are under consideration which contemplate the utilization for electrical purposes of water-powers in Northern Italy, aggregating about 35,000 horse-power.

A Simple Oil Filter.

We illustrate below a simple but effective oil filter which is being manufactured by the Hine & Robertson Company, 68 Cortlandt Street, New York. As will be seen from the cut, the construction is far from complicated, the filter consisting of an outer casing containing three removable trays, each tray provided with a suitable filter cloth through

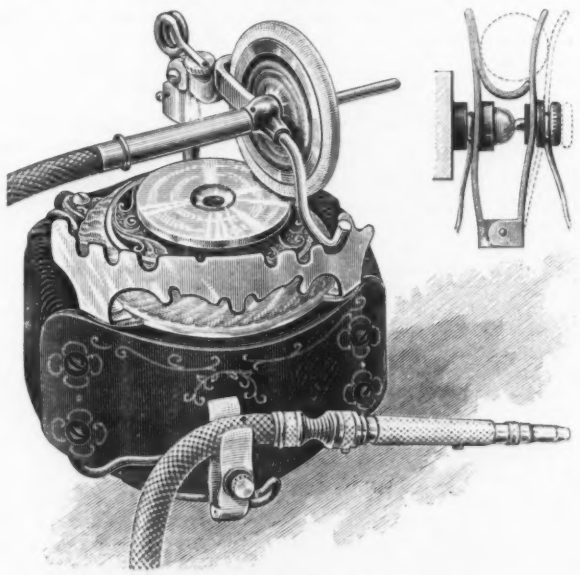


OIL PURIFIER.

which the oil has to pass to reach the outlet near the bottom of the can. Upon leaving the lower funnel, the oil passes through a perforated receiver at the bottom which breaks it up into small globules, and in rising to the surface of the water any remaining impurities are washed out. The filter is constructed of heavily galvanized iron handsomely japanned and striped. All the parts are interchangeable and the work of cleaning the arrangement is that of a very few minutes.

A New Electric Dental Engine.

The accompanying illustration shows a new electrically operated dental engine, for which a patent has been issued to Dr. William E. Wheeler, 128 Lexington Avenue, New York City. The engine consists of an electric motor of special form with a dental engine head attached thereto. The armature of the motor runs vertically between its field magnet poles, the shaft being cone-shaped and provided with a cone-bearing at the lower end, and the upper end carrying a friction disc slightly dished in the centre. At one side of the motor there is an insulated socket in which turns the vertical stem of a standard, the latter being connected with a horizontal stem normally pressed downward by a spring. The outer end of the arm is bifurcated and in the members is journaled the drill-driving spindle carrying a friction wheel, the rubber rim of which rests upon and is driven by the dished-face friction wheel on the motor



ELECTRIC DENTAL ENGINE.

spindle. One of the members of the bifurcated arm has an extension bent downward and adapted to engage in a notched segmental support so that by lifting the arm the rubber rim friction wheel can be shifted toward the periphery of the driving friction wheel and the speed increased, while the contrary movement has the opposite effect. On the opposite side of the motor an automatic switch and cable clasp is provided, consisting of a pair of spring arms with which are connected the terminals of the circuit supplying current for the motor. When the cable is laid in this clasp the arms are separated and the circuit broken, so that it is impossible for the motor to operate with the cable in this position of rest. Removing the cable from its clasp obviously has the effect of starting up the motor.

Some New Electrical Specialties.

The accompanying illustrations show some of the new specialties recently brought out by the Heilbron Brass Works, St. Paul, Minn., Fig. 1 representing the Grutting electric soldering iron, in the construction of which the manufacturers have spared no pains to produce a practical and reliable tool. The heater is hermetically sealed in a cast-iron cylinder and is made of non-fusible material, principally carbon. These irons are made in three sizes, one inch in diameter for

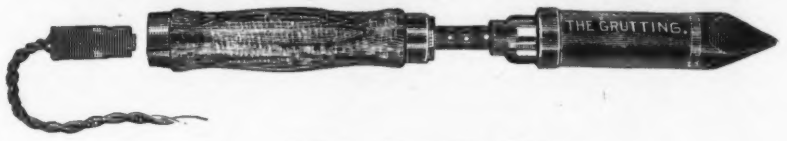
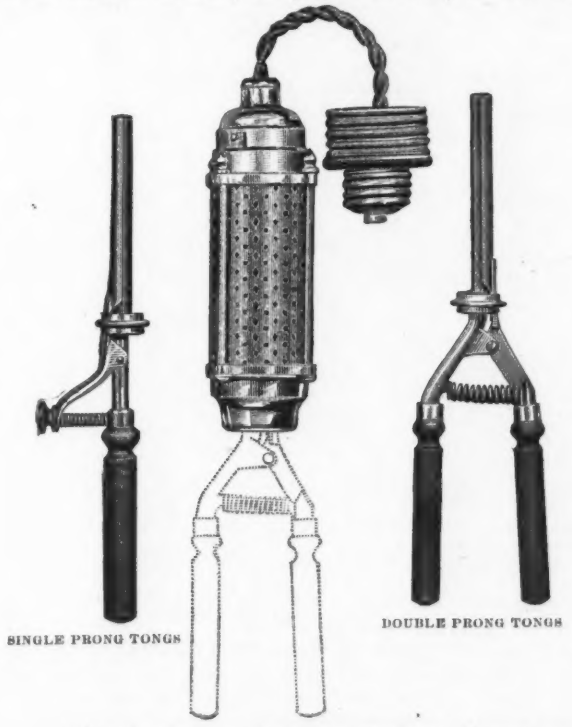


FIG. 1.—SOLDERING IRON.

very light work, 1¼ inches in diameter for general use in electric light stations, factories, etc., and 1⅜ inches for heavy and continuous service, such as commutator and armature work. They are provided with interchangeable copper tips, so that when one is worn down another may be substituted at inappreciable expense. The contact plug fits all three of the sizes, so that only one plug is necessary for any number of



FIGS. 2 AND 3.—ELECTRIC CURLING TONGS.

irons not used simultaneously. Figs. 2 and 3 show electric curling irons, one being single prong and the other double prong. These are nickle plated and very neatly gotten up. The heater is contained in the "housing" shown in the centre of the cut, in which the tongs are inserted when it is desired to heat them.

Recent Damage by Lightning.

At Crewe, on June 6, lightning struck a chimney in the railway works, and the chimney fell. Chimney-stacks in Alton and Lockett streets were also smashed. At Normanton two miners returning from their employment were killed by a flash of lightning. At Hammersknott Park, the site of the Royal Agricultural Society's Show, five people seeking shelter under an ash tree situated a short distance from the members' pavilion, were struck by lightning, and two were killed. During a heavy thunder storm which passed over Wisbech and district on June 19, one of the lighthouses at Sutton Bridge was struck by lightning and almost completely wrecked. There is a hole nearly six feet wide in the top of the lighthouse, and the walls of the building are cracked in all directions. An American bark, loaded with petroleum, and on a voyage from Philadelphia for Havana, when off the Bahamas, on the night of May 21, was struck by lightning. One of the oil tanks exploded and set fire to the ship. The captain and some of the crew perished; only six survived.—*London Electrician.*

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, July 6, 1895.

ELECTRICAL STOCKS were dull throughout the week, very little interest being manifested anywhere along the line.

AMERICAN BELL reacted slightly from last Saturday's closing. The Commissioner of Corporations has ruled that 194 shall be the price at which the 10,000 new shares of stock is to be offered to stockholders. Inside parties say they do not expect there will be much of this stock left to be sold by auction.

GENERAL ELECTRIC officials are much encouraged by reason of obtaining the contract for equipping the Chicago Lake Street elevated road, arguing that this, on top of the Nantasket Beach and Chicago Metropolitan contracts, will give the company considerable prestige.

	Par.	Bid.	Asked.
ELECTRICAL STOCKS.			
Chicago Edison Company	100	120	125
Edison Electric Ill., New York	100	99¾	101
" " " Brooklyn	100	..	108
" " " Boston	100	129	130
" " " Philadelphia	100	..	115
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	28½	29¼
General Electric	100	36¼	36½
General Electric, pref	100	70	71
Westinghouse Consolidated, com.	50	35	37
" " pref	50	53	..
BONDS.			
Edison Electric Ill., New York	100	105½	105½
Edison Electric Light of Europe	100	75	85
General Electric Co. deb. 5s	100	..	90¼
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	194	194¾
American District Telegraph	100	30	40
American Telegraph & Cable	100	94	97
Central & South American Telegraph	100	117	120
Commercial Cables	100	159	..
†Erie Telephone	100	56¾	57½
Gold & Stock Telegraph	100	105	..
New England Telephone	100	..	77
New York & New Jersey Telephone	100	103	105
Postal Telegraph-Cable	100	63⅛	..
Western Union Telegraph	100	91½	91⅝
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	20⅝	20⅞
Binghamton RR. com	100	100	..
Brooklyn Traction	100	16½	18
" " pref.	100	..	58
Buffalo St. Ry	100	86	90
Cleveland City Ry.	100	68	70
Cleveland Electric Ry.	100	59	60
Chicago City Ry	100	305	315
Columbus St. Ry	100	48¼	..
Consolidated Traction of N. J	..	26	30
‡Electric Traction, Philadelphia	50	73½	74¼
Hestonville	100	59	60
Long Island Traction	100	11½	11¾
Louisville St. Ry. com.	100	37	39
" " " pref.	100	87	887
New Orleans Traction	100	24	24½
" " pref.	100	69	71
North Shore Traction	100	34½	37
" " pref.	100	84	88
People's Traction $30 pd	25	61½	62
Philadelphia Traction	50	82½	83¼
Rochester St. Ry	..	38	..
Union Ry. (Huckleberry)	100	112	115
West End, Boston	100	72	72¼
" " pref	100	..	20
Worcester Traction	100	18	20
" " pref	100	86	90
BONDS.			
Buffalo St. Ry. 1st con. 5s	100	106	108
*Binghamton Railroad Co. 5s	100	99	100
*Columbus St. Ry. 1st 5s	100	104	..
Rochester St. Ry. 1st. 5s	100	95	97
*Union Ry. 1st. mtge 6s	100	105	108
*Westchester Electric 1st. mtge. 5s	100	98	101

* With accrued interest.
† Ex-Div.
‡ Ex-rights.

The Annual Report of the Westinghouse Electric & Manufacturing Company.

The annual report of the board of directors of the Westinghouse Electric & Manufacturing Company to the stockholders was issued on July 2. The opening paragraphs refer to the all-important features of the year's business, which was the creation of magnificent workshops having unequalled facilities for the carrying on of business and the manufacture of apparatus heretofore conducted in three widely separated works with material stored in numerous warehouses. The new works, it is added, were erected during a period when extremely low prices for labor and material have prevailed so that the cost shown in the accompanying balance sheet is greatly below earlier or present prices for like work. As was expected, such extensive building operations and the removal of materials from old to the new works reduced the output to about three fourths of what it would have been without the interruption and extra work entailed. The directors invite all holders of the company's stock to attend in person the annual meeting on July 17, at Pittsburg, in order to take advantage of the opportunity to see for themselves what has been accomplished and so form their own opinions of the efficiency of the plant and value of the property. Meanwhile the directors feel justified in adding that the works are as nearly perfect as they can now be made and are working to the entire satisfaction of those in charge; the production has already been increased to a point where the demands of all customers can be promptly met and there appears to be no reason why the company should not be as large a producer of electric machinery as there is in the country. In anticipation of the increased facilities in the new shops a large amount of time and energy were put into the production of new and better forms of apparatus for the trade, and this extra work, together with that incident to occupying the new quarters, increased the expenses to a figure somewhat exceeding that of the year ending March 31, 1894. So far as ascertained, there were expended directly in removing, in machinery and in material, $90,499.54; after deducting this from the earnings from business and other sources, there is left the net profit of $711,909.68, which, however, scarcely represent half what might reasonably have been expected were it not for the conditions referred to above as to limitation of output.

LIGHT AND POWER PROPERTIES.—The United Electric Light & Power Company, of New York, in which the Westinghouse Company is interested, has acquired almost all of the stock of the Brush Illuminating Company and the United States Illuminating Company, both of New York City, and is now building and will soon have in operation one of the most comprehensive light and power stations in the United States. It has contracted with the Westinghouse Company for ten 1,000-hp electric outfits, including converters and other apparatus, half of which outfits were used for the World's Fair lighting. On the conclusion of the above contract the Westinghouse Company will have the following securities of the United Company:

First mortgage bonds	$913,000
Preferred stock	550,400
Common stock	411,700

of which, under the terms of the reorganization, there have already been received for material unsecured notes, claims, and for a cash subscription of $200,000:

First mortgage bonds	$548,000
Preferred stock	187,500
Common stock	411,700

From its old stations this company is doing a business of about $800,000 per annum, which should be more than doubled with the new station, giving a net revenue sufficient to pay interest on its bonds and dividends and all of its stock, there now being a demand for light and power sufficient to absorb the entire surplus of the stations of all existing companies.

THE BRUSH ELECTRIC COMPANY, OF BALTIMORE, M. D., is another enterprise in which the Westinghouse Company is interested. In its reorganization the latter subscribed for $40,000 first mortgage 5 per cent. bonds and took in payment for machinery $170,000 first mortgage 5 per cent. bonds, making a total holding of $210,000 first mortgage 5 per cent. bonds. It is also the owner of 5,060 ($100) shares of the common stock of a total of 7,292 shares outstanding. The station of the Baltimore Brush Company is new and one of the finest in the country; it has three of the World's Fair 1,000-hp generators and has been supplied with a large amount of other electrical apparatus, and will be hereafter, as is the New York company, a constant purchaser of apparatus and supplies. It is added that the value of the securities of both properties will, it is believed, be equal to or above the par value in the near future and that the final profit on these securities will be a large one. The report states that the management anticipates a great addition to its business from the experience gained with these two companies and building other light and power stations throughout the country and the rebuilding on like lines of many antiquated plants, managers of which are rapidly being forced to the conclusion that they can only continue to have a profitable business and successfully meet any competition that may arise by using multiphase direct-connected alternating generating apparatus, whereby motors and all other services can be had from one class of machinery. The statement in the last report is repeated that the Westinghouse Company has no contracts of any character with local lighting and other companies which can in any way interfere with the sale of its apparatus. A letter from President Higginbotham, of the World's Fair, is included in the report speaking in high terms of the manner in which the company carried out its contract and the excellent results which were achieved.

COLLATERAL TRUST BONDS.—The board states that it has authorized the issue of $1,250,000 ten-year 5 per cent. collateral trust bonds, secured by certain bonds and stocks held by the company, provision being made in the deed of trust for the sale of a portion or all of the securities for the cancellation of a corresponding amount of the collateral trust bonds secured thereby; it is proposed to fund out of the purchase of this issue of bonds an equal amount of debt, the greater part of which has been created in the building of the new works, purchase of new machinery, and the outlays in connection with the financial plans of the United and Brush companies.

ENGLISH WESTINGHOUSE COMPANY.—Additional patent rights have been sold during the year to this company and the preferred and common stock of the principal English stockholders purchased with the proceeds, so that the parent company now owns $782,500 preferred and $1,807,400 common stock out of $2,322,750 outstanding, and will hereafter direct all of its affairs. All apparatus sold by the London company has been purchased from the parent company at profitable rates and its business has also been profitable the past year, having netted nearly 5 per cent. on a valuation of $1,000,000. It is proposed to push the business in Great Britain, European countries and the various colonies, there having been many inquiries during the past year to which it has been unable to respond, owing to lack of manufacturing facilities, patents and litigation.

LITIGATION.—It is reported that the company has been successful in favorably terminating litigation with respect to incandescent lamps, feeder and main and other important patents, and was especially successful in the Bate refrigerator case, in which the life of a number of patents which were being used to influence trade by rival companies was finally determined. In the McKeesport case, argued in the Supreme Court in October last, involving the ownership of the carbon filament for incandescent lamps, no decision has yet been handed down, but it is not considered that the delay is unfavorable to the sustaining of the claims of the Sawyer-Man patent. The directors believe that with the exclusive control of the Tesla patents its position in patent matters is more favorable than any of its competitors.

UNDERGROUND CIRCUIT STREET RAILWAYS.—Reference is made to the recent purchase of a controlling interest in the Electromagnetic Traction Company, of West Virginia, whose system has been in continuous operation in Washington, D. C., during the past year, and is now in successful operation at the Westinghouse works in Pittsburg, where it is used for moving freight cars and for general work. This arrangement, it is stated, appears to be a complete solution of the problem of street car propulsion in all large cities and should give the company a large amount of additional business.

TESLA INVENTIONS.—The report refers to the ownership of the exclusive right to manufacture and sell apparatus under the patents of Nikola Tesla covering alternating currents for power distribution; the rights under the separate patents are claimed to be of great value for developments indicate, it is stated, that it is only by means of Tesla's inventions that elevated and long lines of railway can be successfully operated and that power can be most economically distributed over wide areas and throughout workshops. All the machinery in the East Pittsburg factory are driven by Tesla motors and it is stated that orders for like apparatus have followed the inspection of the successful manner in which this work is there done. The 5,000-hp generators contracted for by the Niagara Cataract Construction Company have been put in successful operation and other important installations for power transmission under Tesla patents have been made in various parts of the country. Recently a short branch of the Pennsylvania Railway has been fitted with the ordinary electrical apparatus for the propulsion of steam cars and tests have been entirely satisfactory. The manufacture of multiphase motors under the Tesla patents is being pushed forward for practical tests in running steam cars, elevated cars on long lines, the success of which will be of special importance in insuring a large amount of trade for which there will be no competition. Suits on the Tesla patents are pending against the Stanley Company, of Pittsfield, Mass., and the Thomson-Houston Company. The defendants in the latter case have been limited to Oct. 7 within which to close testimony, and it is the intention to push these and all cases of infringement to a hearing in order that the exclusive privilege which these patents involve may be enjoyed. It is stated that while heretofore a very large percentage of the business of the company has been done by means of apparatus using continuous currents, it is now assumed that the percentage will change so that in the near future the bulk of the business will be done by means of the multiphase apparatus involving the use of Tesla's inventions.

CAPACITY OF THE NEW WORKS.—It is stated that the present capacity is sufficient for the employment of between 4,000 and 5,000 men; the various buildings have been so arranged that the main workshop can be readily extended and the capacity of the works developed at a comparatively small outlay without interfering with the regular manufacturing business during building operations. Outside of the main buildings the others already have the required capacity, and there is still available for future buildings nearly one half of the 40 acres owned by the company. In conclusion it is stated that indications are that the demand for electrical apparatus in general will be greater during the next 12 months than for any other period in the past, and it is therefore of great importance that the new works are in complete operation. The following is the balance sheet, dated March 31, 1895:

ASSETS.

Cash in banks		$202,880 89
Bills receivable		80,133 81
Accounts receivable		2,146,131 10
Material in stock and in process of manufacture (at cost of labor and material)		2,120,227 95
Advances to leased companies		149,588 20
Bonds (par value $866,206 17)		811,271 38
Stocks (par value $8,656,109 72)		4,092 519 40
Real estate and buildings, Pittsburg		464,403 48
New factory—land and buildings	$1,186,780 22	
Less—first mortgage on land and buildings (final payment due April 1, 1900)	$400,000 00	
Second mortgage on land (final payment due April 1, 1896)	115,000 00	
First mortgage second purchase of land (due July 1, 1899)	59,300 00	574,300 00
Total		612,450 22
Machinery and tools		1,159,842 44
Miscellaneous		70 292 77
Charters, franchises and patents		4,404,499 45
		$16,314,241 09

LIABILITIES.

Accounts payable		$403,017 02
Bills payable, issued for merchandise		379,222 36
Discounted with collateral		1,265,000 00
Contract and Contingent Liabilities		
Scrip dividend		194,860 00
Stock subscription		13,125 00
Collateral trust bonds		250 000 00
U. S. Elec. Light. Co.'s 6 per cent. 15 year bonds $50,000 payable annually		500,000 00
(Bills receivable under discount $396,972.37.)		
Capital Stock.		
Preferred, 79,865.31 shares	$3,993,265 50	
Assenting, 103,779.02 "	5,188,951 00	
Common, 2,954 "	147,700.00	
		9,329,916 16
(In treasury 13,266.98 shares assenting and 574.69 shares preferred.)		
Surplus		3,979,400 21
		$16,314,241 09

SURPLUS.

Surplus balance, March 31, 1894			$3,822 049 38
Twelve months' net earnings from business	$734 698 85		
From other sources	67,710 37	$802,409 22	
Less expense applicable to moving factories		90,499 54	711,909 68
			$4 533,959 06
Less amounts written off in adjustment of matters pending prior to current year		$78.031 86	
Adjustment and depreciation in current year		133,408 00	211,439 86
			$4,322,519 20
Interest on bonds and mortgages		$57,386 61	
Interest on scrip		11,673 60	
Dividends paid		274,058 78	343,118 99
Surplus balance March 31, 1895			$3,979,400 21

Special Correspondence.

NEW YORK NOTES.

OFFICE OF THE ELECTRICAL WORLD,
253 BROADWAY, NEW YORK, July 8, 1895.

MR. A. M. FITZ, of Lynn, Mass., has been appointed representative of the Boston Incandescent Lamp Company for New York City and vicinity.

THE NEW TROLLEY LINE of the North Hudson County Company, extending from the ferry at Weehawken to Fort Lee was opened for traffic yesterday, though with a limited number of cars. More cars will be added this week.

MR. R. T. LOZIER has withdrawn from the firm of Warren & Lozier, and gone to Europe for the benefit of his health. The business will be carried on as heretofore, but under the firm name of A. K. Warren & Co., at the old address, 465 Greenwich Street, New York.

THE BERNSTEIN ELECTRIC COMPANY, of Boston, has opened an office at 39 Cortlandt Street, with Mr. A. L. Fenton in charge as its agent. This is an excellent move and one which will undoubtedly result beneficially to the company as Mr. Fenton is a popular and wide-awake man and thoroughly familiar with the lamp business.

LONG ISLAND'S TELEPHONE WAR has been brought to an end by the absorption of the plant of the Orient, Montauk and New York Telephone Company by the New York and New Jersey Telephone Company. The latter is rapidly pushing the extension of its facilities and expects to reach Greenport with lines some time next week.

NEW ENGLAND NOTES.

BRANCH OFFICE OF THE ELECTRICAL WORLD,
ROOM 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, Mass., July 6, 1895.

THE NATIONAL TELEPHONE MANUFACTURING COMPANY of Boston, has been compelled to enlarge its office accommodations at 620 Atlantic Avenue, owing to its rapidly increasing business. Many corporations doing only a small percentage of the business transacted by the National Telephone Company would be housed in palatial quarters, but Treasurer J. D. Leatherbee is a matter-of-fact man and does not believe at all in display, preferring to handle the affairs of his company on purely business principles and not to anticipate the growth of business which the merits of the company's manufactures is bringing about so rapidly.

MR. CHARLES BROWN PRICE, general manager of the Pettingell-Andrews Company, of Boston, after a quiet bridal trip of about three weeks, is back again at his desk, and the numerous congratulations of which he is the recipient testify abundantly to the esteem in which he is held by the electrical trade generally. The marriage of Mr. Price occurred on the evening of June 5, at Peabody, Mass., the bride being Miss Mary Agnes Grosvenor, a charming young lady of that city, daughter of Mr. Daniel P. Grosvenor, one of Peabody's most prominent citizens. THE ELECTRICAL WORLD joins in congratulations and the sincere wish that happiness and prosperity may always attend them.

THE HOLLY STEAM ENGINEERING COMPANY, 343-344 Butler Exchange, Providence, R. I., is making some strong entering wedges with prominent steam plants for the Holly gravity return system for utilizing water of condensation. The list of references it furnishes and letters of endorsement received are magnificent testimonials to the value and efficiency of this system. A letter from Mr. L. J. Hirt, assistant chief engineer of the Metropolitan Traction Company, of New York City, under date of June 11, 1895, will undoubtedly carry with it great weight, owing to the prominence and recognized ability of the writer. Mr. Hirt says of this system that it is perfect in its action and requires no attention after being started, automatically taking care of every particle of condensed or entrained water. He thinks the success of the system is due to the constant circulation obtained by the use of the pressure-reducing valve, and expresses his conviction that all the apparatus installed for his company by the Holly Company has far exceeded the guarantees under which it was purchased.

THE EDDY ELECTRIC MANUFACTURING COMPANY, of Windsor, Conn., has just closed important negotiations by which the sale of its well-known apparatus will hereafter be under the control of stronger parties than ever before and be pushed with the energy and vigor its merits demand. It will hereafter be represented in New England by G. M. Angier & Co., of 64 Federal Street, Boston; in New York by H. B. Coho & Co., Mail and Express Building, and in Central New York State by Mr. S. N. Blake, at Elmira N. Y. Mr. F. C. Ross, who has represented the Eddy Company in New York for some years, will be identified with Messrs. Coho & Co. as salesman. This arrangement brings the Eddy Company in close touch with prominent and wide-awake business firms enjoying excellent reputations and recently particularly well known because of their connection with the Mather Electric Company. The consummation of these negotiations will undoubtedly strengthen the business future of both the Eddy Company and its new representatives and incite to still greater activity the fertile brains and apparently inexhaustible energies of Messrs. Eddy, Newton and Baird, of the home office.

English Notes.

(From Our Own Correspondent.)

London June 26, 1895.

THE ELECTRIC SUPPLY BUSINESS IN LONDON.—Statistics with regard to the progress of the electric supply business in London show that close upon four millions sterling has been sunk in electric light undertakings in the metropolis, and that these four millions bring in about £870,000 a year gross income, the ratio of expenditure to gross receipts being during 1894 a little over 60 per cent. While the capital outlay increased during 1894 by 11 per cent., the output of the metropolitan stations increased by nearly 40 per cent. The average total cost per kilowatt-hour sold was reduced during 1894 from 4¾d. to a little over 4d. This figure is, for the more successful companies of course, considerably lower, the average being tremendously affected by the unfortunate operations of the London Electric Supply Corporation and one or two other companies almost equally bad.

FIRE AT AN ELECTRIC CENTRAL STATION.—On Monday evening, soon after 6 o'clock, the Sardinia Street station of the Metropolitan Electric Supply Company, which is fitted throughout with Westinghouse apparatus, caught fire, and was practically destroyed, notwithstanding the prompt arrival of a large force of fire engines and the efforts of the staff to avert a catastrophe. The fire commenced from some unknown cause, in the top part of the building. The electric service of a large number of restaurants, hotels and theatres was affected, but only for a short time, the district ordinarily supplied from the damaged station being promptly connected to one of the other stations belonging to the Metropolitan Company. This is the second fire in a London central station which has occurred this year. It is only about two months ago that a serious fire occurred at one of the stations belonging to the Kensington & Knightsbridge Company.

ELECTRIC SEASHORE RAILWAY.—About twelve months ago, Mr. Magnus Volk, who for some time had been running a toy electric railway along the Brighton Beach, obtained parliamentary powers to run a unique type of electric railway from Brighton to a small village near at hand, Rottingdean by name. The track runs along the seashore and is, at times of high tide, entirely submerged by the waves. The vehicle containing the passengers consists of a large elevated platform which carries the travelers over the water well above the wash of the waves. At the last moment there seems to be some likelihood of this novel scheme falling through. The promoters, it seems, have not been able to ascertain the amount of power which will be required to propel their peculiar type of car through the water, and have therefore applied to the Brighton Town Council for permission to temporarily propel the platform by means of a steam engine. So great, however, is the fear of the Brighton authorities lest the beauties of their sea front should be marred in any way, that after a lengthy debate they decided by 28 votes to three, not to accord the permission desired. The promoters therefore, will either have to lay down a sufficient electric plant to cover contingencies, or abandon the scheme altogether.

CENTRAL LONDON RAILWAY.—In 1891 parliamentary permission was obtained to run an underground electric railway right across London, from west to east, terminating in the heart of the city, near the Mansion House, Royal Exchange, Bank of England, etc., the length of the line being six and one half miles with twelve intermediate stations. Up till Monday last, the powers have lain dormant owing, it has been alleged, to the lack of confidence of the British public in electric traction enterprises. I do not know whether the confidence of the British public has recently grown, but it would not appear to have done so, as it is only a month or two since that the British public failed to subscribe sufficient funds for an electric railway which was brought out under the auspices and with the financial support of the Great Northern Railway Company. The promoters of the Central London Railway, however, apparently think that the confidence of the public has increased sufficiently to enable the company to obtain nearly three millions sterling. The engineers of the line are Sir John Fowler, Sir Benjamin Baker and Mr. Greathead. The construction of the line is to be carried out by the Electric Traction Company, about which very little is known, except that it has a subscribed capital of £300,000. The Central London Railway is to be opened for traffic by Dec. 31, 1898.

General News.

New Incorporations.

THE ST. CLAIR TELEPHONE COMPANY, Appleton, Mo., has been formed by O. E. Robinson and J. M. Burns.

THE BUFFALO, GARDENVILLE & EBENEZER RAILWAY COMPANY, Buffalo, N. Y., has been incorporated, with a capital stock of $40,000.

THE FORT PITT STREET PASSENGER RAILWAY COMPANY, Pittsburg, Pa., capital stock $50,000, has been incorporated by Joshua Rhodes and others.

THE MAGIC CITY TELEPHONE COMPANY, Barberton, O., has been formed by W. S. Holloway, John McNapara, F. G. McCauley, George A. Shaw and others.

THE BULLARD ELECTRIC COMPANY, Chicago, Ill., has been incorporated by Charles W. Bullard, Albert S. Bullard and Carl F. Kammeyer. The capital stock is said to be $25,000.

THE INDIANAPOLIS, ANDERSON & MARION RAILWAY COMPANY, Indianapolis, Ind., has been incorporated by Noah J. Clodfelter and others, with a capital stock of $500,000.

THE FREDONIA TELEPHONE COMPANY, Fredonia, Kan., capital stock $5,000, has been incorporated by Charles L. Morton, F. W. Stevenson, A. C. Flack, G. S. Paulen and Atwood Cady.

THE FRAMINGHAM TELEPHONE COMPANY, Framingham, Mass., has been formed to furnish telephone service in Framingham and Natick. The capital stock is reported as being $15,000.

THE NEWARK MUTUAL TELEPHONE COMPANY, Newark, N. J., has been incorporated by P. J. Atkinson, of New York City; Samuel I. Boyd, of Brooklyn, N. Y., and Ernest J. Ford, of Jersey City, N. J.

THE HAMBURG & PORTLAND TELEPHONE COMPANY, Little Rock, Ark., has been organized; the capital stock is $3,000, and the incorporators are J. D. Pugh, Charles M. Woodward, J. H. Pryor and others.

THE CITIZENS' ELECTRIC COMPANY, Mishawaka, Ind., capital stock $10,000, has been formed to furnish electric light and power. John H. Egbert, David O. Fonda, and Martin V. Beiger, and Jas. A. Roper are interested.

THE CONSUMERS' LIGHT & POWER COMPANY, Spokane, Wash., capital stock $250,000, has been incorporated. S. Oppenheimer, W. R. Newport, A. D. Hopper, J. W. Binkley, M. J. Waller, H. A. Van Kempen and E. J. Dyer are interested.

THE WILDE TIDAL POWER COMPANY, Kittery, Me., capital stock $500,000, has been formed to make and deal in machinery for developing electricity by means of tidal water. John Wilde, Lorin M. Cook and Alfred Caldwell, Providence, R. I., are the promoters.

THE AMPLIFIED ELECTRIC COMPANY, East St. Louis, Ill., has been incorporated. The capital stock is reported as $1,000,000; the incorporators are Frederick Ulrich, Edwin J. Paule and John T. Dodwell. The company proposes to manufacture electrical appliances.

THE SHEBOYGAN LIGHT, POWER & RAILWAY COMPANY, Sheboygan, Wis., capital stock $200,000, has been formed to supply light and power and to build an electric railway. The promoters are Geo. B. Matten, J. M. Saemann and F. L. Saemann, all of Sheboygan.

THE ELECTRIC BOAT COMPANY OF NEW YORK, New York City, capital stock $8,000, has been formed to manufacture and deal in electrical propellers for boats and electrical appliances in general. The promoters are F. S. Allen, I. T. McDowell and C. H. DeWitt, of New York.

THE CHAPLIN COMPANY, Kittery, Me., capital stock $75,000, has been formed to manufacture, buy and sell electrical, mechanical and chemical inventions. The interested parties are Edwin D. Chaplin, Cambridge; Hiram L. White, Somerville, and Henry C. Halloran, Boston, Mass.

THE SYRACUSE & SUBURBAN RAILWAY COMPANY, Syracuse, N. Y., has been formed by W. B Cogswell, O. V. Tracy and G. E. Higgins, Syracuse, N. Y., for the purpose of building and operating an electric street surface road in Onondaga County. The capital stock is reported as $250,000.

THE UNION ELECTRIC COMPANY OF CHARLEROI, Charleroi, Pa., capital stock $1,000, has been formed to furnish electricity for light, heat and power. H. S. Stewart, Jas. S. McKean, Pittsburg; Jno. A. Irwin, Jas. S. Carr, Allegheny; Harry W. Gleffer, Haysville, Pa., are interested parties.

THE BUFFALO, NORTH MAIN STREET & TONAWANDA COMPANY, Buffalo, N. Y., capital stock $75,000, has been formed to operate the Buffalo, North Main Street & Tonawanda Electric Railway Company. S. W. Petrie, T. H. Feary and J. H. Pardee, Buffalo, and J. F. Farrell, Albany, N. Y., are interested.

THE GREENWICH & SCHUYLERVILLE ELECTRIC RAILWAY, of Greenwich, N. Y., has been formed with a capital stock of $200,000, to build and operate an electric railway. Martin Schenck, Troy; Jas. Mealey, Schuylerville; A. M. Crandall, Middle Falls and Robert Hamilton, Greenwich, N. Y., are the incorporators.

THE DALLAS CITY STREET RAILWAY COMPANY, Dallas, Tex., has been incorporated with a capital stock of $500,000, to construct and maintain a street railway in Dallas to be operated either by horse, electric or cable power. The promoters are Frank Clark, Baltimore, Md.; C. L. Blackford, Denison Tex.; I. L. Sale, Dallas, Tex.

THE INTER-OCEAN ELECTRIC RAILWAY COMPANY, Chicago, Ill., capital stock $200,000,000, has been formed to construct, equip, own and operate electric railways, both surface and elevated, and to erect and operate telephone and telegraph lines, etc., etc. Among the interested parties are Jas. C. Hulse Parker Crittenden and John W. Hill.

THE CONSOLIDATED ELECTRIC PURIFIER COMPANY, Chicago, Ill., capital stock $1,500,000, has been formed to own, control and deal in and operate under letters patent, particularly such as relate to improvements in machinery, steam boilers and engines, also fittings and attachments for same. A. M. Befield, Wm. C. Ancher and J. W. Hill are interested.

THE ARKANSAS CITY & NORTHWESTERN CONSTRUCTION COMPANY, Jersey City, N. J., capital stock $500,000, has been formed to build, maintain and operate railways and steamboat lines, and to construct, develop and promote electric railways. Marion W. Lewis, Boston, Mass.; J. B. Leake, New York, and Geo. L. Dayton, Jersey City, N. J., are the organizers.

THE PENN INSULATED WIRE COMPANY, Camden, N. J., capital stock $150,000, has been formed to manufacture all kinds of insulated wire cables, paper, tapes and insulating compounds for electrical purposes. Franklin S. Randall, 4906 Franklin Street; W. H. Holden, 4178 Paul Street, and Howard A. Engle, 4407 Frankford Avenue, Philadelphia, Pa., are interested parties.

THE GAS CONSUMERS' ASSOCIATION OF THE UNITED STATES, San Francisco, Cal., capital stock $300,000, has been incorporated by J. D. Whitney, J. R. Spring, Sampson Tanes, Isaac Hecht, Henry Kerber, Jr., San Francisco; D. L. Randolph, Alameda, and Carter P. Pomeroy, San Rafael. The object is to make and sell electric light and gas fixtures, supply illuminating gas, etc.

TELEGRAPH AND TELEPHONE.

MENASHA, WIS.—The Wisconsin Telephone Company has been granted a franchise for an exchange by the Menasha City Council.

SYRACUSE, N. Y.—Application has been made to the City Council by Thos. Ryan, Chas. M. Warner, John Dunfee and others, for a franchise to erect and maintain a telephone or telegraph system for public and private use.

RICHMOND, VA.—Judge Wellford of the Circuit Court has granted a charter to the Southern Electric Construction Company. The purpose of the company is to construct and equip telephone plants and exchanges, electric light plants and do a general electric business. J. M. Cullingworth is president.

ELECTRIC LIGHT AND POWER.

TROY, MO.—The citizens have voted to put in a municipal plant.

GROUSBECK, TEX.—F. Allen of Kasse, is securing subscriptions for an electric light plant.

TOLEDO, OHIO.—The Western Electric Light & Power Company will enlarge its plant to the extent of $200,000.

JANESVILLE, WIS.—The city authorities have decided to install 66 arc lamps to light the streets in place of gas.

WASHINGTON, D. C.—The Treasury Department has authorized the installation of an electric light plant in the Sub-Treasury building at New York.

CONNORSVILLE, IND.—Proposals will be received by the city authorities until noon, July 11, for the complete electric light plant of a capacity of 80 2,000-cp arc lamps.

WASHINGTON, D. C.—The Department of the Interior is open until July 22 to receive proposals for supplying and installing an electric light plant at the Government Hospital for the Insane.

MARCUS HOOK, PA.—The chairman of the police and light committee will receive sealed proposals until July 19 for lighting the street of the borough for a period of one to five years, beginning Aug. 15.

THE ELECTRIC RAILWAY.

JACKSONVILLE, FLA.—The Jacksonville Street Railway Company has been adding new machinery to its plant.

DE SOTO, MO.—A franchise has been granted St. Louis parties for an electric railway from St. Louis to Morse's Mills.

GENEVA, N. Y.—The right of way for an extension of the electric railway, making a belt line about the town, has been secured.

PORTSMOUTH, VA.—The Board of Supervisors has granted the Portsmouth Electric Railway Company right of way through additional city streets.

BALTIMORE, MD.—The Canton, Sparrow's Point & North Point Electric Railway will probably build a power house of 1,000 hp. F. W. Wood is interested.

CUMMINGSVILLE, O.—A company is to be formed to construct an electric street railway from Cummingsville to Mt. Airy. The capital stock will be $100,000.

DETROIT, MICH.—John B. Maloney and others have organized a company to operate an electric line between Detroit and Dearborn. The capital stock is $50,000.

NEW YORK, N. Y.—A company proposes to build a new suburban trolley road from Mount Vernon to White Plains as a link in the electric railway system.

NEWBURYPORT, MASS.—The Board of Aldermen has granted the People's Street Railway Company an extension of time in which to build a line through Storey Avenue to West Newbury.

FAR ROCKAWAY, L. I., N. Y.—The application of the Long Island Electric Railway Company for a franchise to build a trolley line in Central Avenue has been refused by the village trustees.

INDEPENDENCE, MO.—The Kansas City & Independence Rapid Transit Railway Company, of which C. F. Holmes is general manager, is considering plans for extending its electric road in Independence.

WASHINGTON, D. C.—The Washington & Great Fall Electric Railway of which J. P. Clark is president, and W. E. Lewis, secretary, has sold bonds to the amount of $100,000 for the purpose of constructing its electric railway.

EAST WEYMOUTH, MASS.—An extension of location has been granted to the Braintree & Weymouth Street Railway Company, from Jackson Square through Commercial and Station streets to the N. Y., N. H. & H. Railway depot.

TUCKAHOE, N. Y.—The probabilities are strongly in favor of a trolley line from Tuckahoe and Bronxville to White Plains and Mt. Vernon. The new line will be an extension of the North Mt. Vernon Railway in which John D. Crimmins is largely interested.

TOWSON, MD.—A stock company has been formed by Geo. S. Metter, Dr. W. Crim, S. J. Carr, of the Carr-Lowery Glass Company, and Wm. F. Porter, of Johns & Porter, and others, for the purpose of building an electric railway to connect Mt. Winans, Westport, Lansdowne and Metter's Park with Baltimore. The capital stock is $75,000.

JAMAICA, L. I., N. Y.—Col. A. A. DeGrauw, one of the wealthiest men and a large stockholder in the Jamaica & Hempstead Plank Road, has asked the Town Board of Jamaica to postpone proceedings to have the road condemned, as he is about negotiating with an electric railway company to build a trolley line over this route, from Jamaica to Hempstead.

DAYTON, O.—The Dayton Traction Company has announced that arrangements are perfected, whereby the road will be completed, and the electric line between Dayton and Miamisburg will be in operation by Sept. 1. This line is part of the system in contemplation between Dayton and Cincinnati, and it is said that Mayor Major, of Toledo, is one of the financial backers of the Dayton branch.

Trade and Industrial Notes.

CHANGE IN POLICY.—The Wallace Electric Company, 305 Dearborn Street, Chicago, is closing out its merchandise business and will hereafter operate as manufacturers' agent, representing some of the largest factories and best specialties in the country.

CROWDED WITH BUSINESS, the Helios Electric Company, at present at 1310 Filbert Street, Philadelphia, will remove its office and factory July 20 to 1225-1229 Callowhill Street, where much more room and greatly increased facilities for manufacturing will be had.

A PRACTICAL REFERENCE CARD is being distributed by A. O. Schoonmaker, 158 William Street, New York, containing specimens of mica cut to shape. The specimens are chiefly commutator-segment insulations, among them being all the shapes used by the manufacturers of standard railway car motors.

MR. E. L. BARR, who is well known to the trade through his former connection with the Canadian General Electric Company, and more recent work as travelling salesman for the Wallace Electric Company, Chicago, has been appointed secretary of the latter company, vice Mr. Max Berg who resigned last week.

THE LARGEST BELT IN CHICAGO.—The Chicago manager for the Page Belting Company, of Concord, N. H., reports that he has sold to the Hayward & Morrill Eton Company a three-ply belt 60 inches wide and 112 feet long, which breaks the city record for large belts. The Page Company's western business is rapidly on the increase.

THE ELECTRICAL MAINTENANCE COMPANY, of 50 Broadway, New York, reports having recently closed the following contracts for maintaining and keeping in repair electrical plants: Abraham & Straus, of Brooklyn; the large central station of the New York Heat & Power Company, and the Aldrich Court and Columbia Building plants.

THE SOLDIERS' HOME, at Orting, Wash., has purchased an engine for electric light service from the Ball Engine Company, Erie, Pa. The Ball Company has also sold two 125-hp tandem-compound engines to the Norfolk & Ocean View Street Railway Company and two 175-hp tandem-compounds to the Salamanca Water Works Company, Salamanca, N. Y.

THE ELECTRIC APPLIANCE COMPANY, Chicago, has just made some improvements in the manufacture of its black and white Acme tape which the company claims makes it just a little better than anything that has been heretofore offered. It has been severely tested in the dryest parts of the country, over considerable periods of time, without showing any indication of hardening or drying out.

CLEAN HANDS constitute only one of the many pleasing results attendant upon the use of the electric ranges and cooking utensils described in the new 1895 catalogue issued by the Western Electric Heating Company of St. Paul, Minn. The list of utensils includes griddles, broilers, coffee and tea pots, kettles, chafing dishes, etc. The catalogue describes also electric glue-pots, radiators, sad-irons and goose irons.

A HANDSOME BUILDING has been erected by the Diamond Electric Company, of Peoria, Ill. The new building has three stories, and is 50 x 150 feet; it will be used entirely for manufacturing purposes. New machinery has been put in throughout. Orders for the well-known Diamond transformers have been accumulating so fast that the company has found it necessary to double force, and still work on full time.

THE ADAMS BOILER COMPANY, 807 Cuyahoga Building, Cleveland, O., reports among a large number of recent sales made of the Adams open feed-water heater and purifier, a 500-hp heater sold to the Canton & Massillon Electric Railway, Canton, O.; a 1,000-hp heater to the Cleveland Hardware Company, Cleveland, O.; a 1,500-hp heater to the Girard Furnace Company, Girard, O., and a 300-hp heater to the Sterling Water Works, Sterling, Ky.

DRAWING YOUR SALARY is a pleasant enough task, but to attempt to draw diagrams with inferior instruments is most decidedly the reverse, and in order that draughtsmen may be able to make their work a pleasure the high standard originally adopted for their drawing instruments by Theo. Alteneder & Sons, Philadelphia, has been rigidly and unremittingly observed. Messrs. Alteneder & Sons have just issued a handsome catalogue of their widely known instruments, the list of which includes everything required in a thoroughly equipped draughting room.

THE JENNEY ELECTRIC MOTOR COMPANY, of Indianapolis, on Saturday of last week closed down its old works and on Wednesday started operations in its new factory. The latter comprises a main building 150 feet by 80 feet, two stories high, and detached buildings for the engines and boilers and the testing department. With its constantly expanding business, the Jenney Company had become unpleasantly cramped in its old quarters, but will now have the necessary facilities to promptly fill orders. The situation of the works on the line of the Belt Railway also offers superior shipping accommodations.

THE GLORIOUS FOURTH was again the occasion of a bright advertising inspiration on the part of the American Electrical Works of Providence, R. I., who distributed a natural-looking imitation sky-rocket, the body of which contained a miniature edition of the national flag and a circular printed in appropriate colors conveying the compliments of the sender and the statement that "There is but one American flag and but one American Electrical Works!" The trade has become so accustomed to receiving these clever annual reminders

that they are now regularly expected, and no little curiosity is experienced each time as to just what form the effusion will take.

STILL EXPANDING.—The Washburn & Moen Manufacturing Company has recently acquired the plant and business of the California Wire Works, 8 and 10 Pine Street, San Francisco, and will hereafter operate the same in conjunction with its factories at Worcester, Mass., and Waukegan, Ill. This addition to the company's facilities makes its total plant probably the largest of the kind in the world while the location of the various factories enables it to make prompt shipments from New York, Chicago, San Francisco and other principal cities of the United States. The Washburn & Moen Company has been engaged in the manufacture of wire for over 65 years, during which time it has earned and maintained an enviable reputation for excellence of product and uniform courtesy and integrity in its business dealings. The factory at Worcester employs about 5,000 operatives; that at Waukegan has several thousand hands, and the plant acquired in California is by no means a small one.

USERS OF INCANDESCENT LAMPS will be interested in the announcement that the American Electrical Manufacturing Company, St. Louis, Mo., in its constant endeavors to improve its high grade lamps has engaged Mr. A. L. Reinmann as its superintendent. Mr. Reinmann is favorably and well known to most of the "old timers" in the electrical field as a man of ability and one of the oldest makers of high-grade lamps. He has been in the business from its inception, having worked with Maxim, Stanley and other pioneers and inventors. He was for several years superintendent of the Westinghouse lamp works, Pittsburg, and then became superintendent of the Sawyer-Man Electric Company, New York. The lamps manufactured by his methods have always enjoyed the highest reputation and he has recently completed certain improvements in details of manufacture, which, added to the previous well-known excellence of the "American" lamps, give ample assurance that the customers of the American Electric Manufacturing Company will continue fully satisfied.

Business Notices.

ELECTRIC LEAGUE.—Meets every Thursday evening, 100 West 24th Street, New York. Electrical engineers and electricians cordially invited.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 105 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

UNITED STATES PATENTS ISSUED JULY 2, 1895.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York]

541,919. COMMUTATOR BRUSH; H. B. Collins, Fulton, N. Y. App. filed Jan. 26, 1895. A commutator brush comprising supporting and a hinged contact piece supported by the body and movable on axes arranged at substantially right angles with each other.

541,921. MANUFACTURE OF ELECTRICAL CONDUCTORS; L. W. Downs, Providence, R. I. App. filed April 2, 1895. A process which consists in coating a wire with a fine fibrous covering having a film of rubber thereon, a compact winding of asbestos fibre saturated with soluble glass, and an exterior braided asbestos covering coated with fireproof cement.

541,923. Filed Nov. 21, 1890. 541,924. Filed Dec. 3, 1890 PHONOGRAPH; T. A. Edison, Llewellyn Park, N. J. The combination of a diaphragm suitably supported, a phonogram blank or recording surface, a presser foot pivoted to a support and having a bearing on the phonogram blank, an operating point, and a retarding device between the diaphragm and operating point.

541,929. INCANDESCENT ELECTRIC LAMP; R. Greer, Westbrook, Me. App. filed Nov. 10, 1894. A method for making lamps which consists in placing wholly within a receiver upon suitable supports a glass tube open at its lower end, and then inserting into the said receiver a plug consisting of a filament and its support the base of which is encircled with plastic material, then closing the receiver and exhausting the air therefrom, and then forcing the plug into the glass tube.

541,949. BLOCK SIGNAL FOR RAILWAYS; W. G. Roome, Jersey City, N. J. App. filed April 28, 1892. A signal system comprising a dynamo, an electric circuit leading therefrom, signals serially arranged in the said circuit, a resistance for each signal, a track circuit and a track instrument controlling the signals.

541,967. AUTOMATIC TELEGRAPHY; P. B. Delany, South Orange, N. J. App. filed April 3, 1895. The combination of a transmitter for transmitting current impulses representing dashes, and a receiver having recording devices that record the characters of one kind in one line and the characters of the other kind in duplicate on opposite sides of the first named line of characters.

541,969. TROLLEY-WIRE CLIP; F. W. Haeusgen, Buffalo, N. Y. App. filed Oct. 9, 1894. A clip consisting of an elastic sheet support, its upper ends having apertured projections which register when the wire is in position and which can be pulled apart to admit the wire within.

541,994. DUPLEX AND DIPLEX TELEGRAPHY; M. M. Davis, Brooklyn, N. Y. App. filed April 18, 1895. The combination of a pole changing transmitter consisting of two fixed contact points connected with dynamo-electric generators, respectively, a movable contact consistin of an unequally pivoted lever, the longer arm of which is in position to contact with a fixed dynamo terminal; an electromagnet, an armature therefor mechanically connecting with the shorter arm of the first lever, and an electrical connection between the main line and said first named lever.

541,998. ELECTRIC WIRE JOINT; A. Gartner, Newark, N. J. App. filed May 24, 1895. A wire joint consisting of a tube provided with a longitudinally and spirally arranged slot, the said tube being adapted to be twisted with and around the enclosed wires.

542,002. TROLLEY RESTORING ATTACHMENT; W. D. McDaniel, Philadelphia, Penn. App. filed Oct. 29, 1894. A restoring pulley or pulleys mounted on bearings independent of the trolley wheel, and having a space at their inner ends, the diameters of the pulleys being greater than that of the said wheel.

542,030. AUTOMATIC SAFETY DEVICE FOR ELECTRIC CIRCUITS; Lewis G. Rowland, Camden, N. J. App. filed Feb. 6, 1895. The combination with an electric circuit of a plurality of switches in said circuit, each switch being controlled by an electric device in a closed shunt with said circuit, the resistance of which device is greater than the resistance of the circuit, the arrangement being such that when any device is energized its corresponding switch is operated to open the circuit at said switch.

542,036. ELECTRIC LOCOMOTIVE; Thomas E. Adams, Cleveland, Ohio. App. filed Oct. 3, 1894. The combination with car axles, motors geared therewith and casings for said motors, of gear casings mounted on the axles and having movable connections with the motor casings, said motors being supported by the gear casings independently of the truck frame, and a bar connected with both motors substantially as set forth.

542,049. GALVANIC BATTERY; Ralph W. Gordon, Boston, Mass. App. filed Jan. 31, 1895 In a battery cell the combination with a jar containing an exciting fluid; of a negative element consisting of a receptacle containing a depolarizing agent and having empty chambers therein, the walls of said receptacle and chambers being perforated for the better permeation of said exciting fluid, and a positive element in said exciting fluid.

542,052. TELEPHONE SYSTEM; Angus S. Hibbard, Chicago, Ill. App. filed Feb. 21, 1895. The combination with a telephone line, terminating upon a divided board of the exchange, of an intermediate board, a trunk line extending between said divided board and said intermediate board, and adapted to connect with said telephone line to extend the circuit to the intermediate board; a telephone line terminating upon a second divided board, a trunk line extending between said second divided board and said intermediate board and adapted to be connected with said telephone line to extend the circuit to the intermediate board; means at the intermediate board for uniting the two trunk lines; signaling apparatus at the intermediate board controlled by the subscribers whose lines are connected together, and signaling apparatus at the divided boards adapted to be actuated by the disconnection of the trunk lines at the intermediate board substantially as described.

542,057. ELECTROLYTIC PROCESS AND APPARATUS; Leon P. Hulin, Modane, France. App. filed Dec. 19, 1894. The herein described method of manufacturing a loys which consists in employing as an electrolyte, the fused salts of one metal of the alloy and an anode consisting of a carbon member and a member composed of the other metal of the alloy and varying the current to regulate the composition of the alloy.

542,066. ANNUNCIATOR-CIRCUIT FOR TELEPHONE SWITCHBOARDS; Charles Scribner, Chicago, Ill. App. filed Nov. 12, 1894. The combination with a telephone line, of an annunciator provided with two equal differentially wound helices connected in different parallel branches of the line circuit; a spring-jack provided with a pair of contact terminals normally in contact to include one of said helices in the line circuit, a connecting plug, and contact terminals adapted to be actuated by the insertion of said lug in the spring-jack to include both of said helices in the line circuit.

542,105. CONDUIT ELECTRIC RAILWAY; Leonidas C. Pressley, San Francisco, Cal. App. filed Feb. 13, 1894. In an electric railway, insulated trolley rails fixed within a conduit of alternate lines, a double trolley adapted to form contact alternately with one rail and the other, an electromagnet connected with the terminal end of each rail, and a swinging armature upon which the magnet acts adapted to form contact with the main conductor and energize the electromagnet, as the trolley wheels pass from one rail to the other and temporarily charge the succeeding rail by the current from the preceding one.

542,108. TRAIN ANNUNCIATOR; Charles H. Rittenhouse, Kendallsville, Ind. App. filed Feb. 14, 1895. The combination with the slotted casing, the intermittently rotating annunciator drum, and mechanism for operating the same electrically, of a sliding shutter provided with a rod having stud; cam wheel having offset; and the sheave, weighted cord, and tripping mechanism for restoring the drum to its initial position automatically.

542,164. CONDUIT ELECTRIC RAILWAY; Louis R. Lavelle and Albert H. Lavelle, Holyoke, Mass App. filed March 17, 1894. The combination with the switch and trolley wires having bent ends, of the supporting and insulating blocks to carry the wires, the blocks having recesses in their bottoms to receive fastening nuts on the wires, and insulating cushions arranged between the wires and the blocks.

542,191. MAGNETO-ELECTRIC TELEPHONY; Edward S. Halsey, South Evanston, Ill. App. filed April 20, 1894. In magneto-electric telephones the combination with a vibrating diaphragm, of an exciting magnet having a movable pole terminal and opposite dual pole terminals confronting the same with the coil for the electric circuit within their inductive field, and a connector located between the diaphragm and the movable pole terminal whereby the latter shifts in keeping with the shifts of the diaphragm.

542,210 SAFETY DEVICE FOR HANDLING ELECTRIC ARC LAMPS; Edward P. Snowden, St. Joseph, Mo. App. filed March 22, 1895. In a safety device for handling electric arc lamps the combination of block conductors, spring conductors, switch, switch conductor and notch or spring switch receiver and bracket.